Monreta


# SCIENTIFIC AMERICAN SUPPLEMENT

Copyright 1913 by Munn & Co., Inc.

VOLUME LXXVI]
NUMBER 1965 ]

NEW YORK, AUGUST 30, 1913

[10 CENTS A COPY
[$5.00 A YEAR


# Glaciers and International Boundaries

## How One Nation Gained Hundreds of Square Miles of Territory


By Prof. Lawrence Martin, University of Wisconsin

Leader of the National Geographic Society's Alaskan Expedition of 1910 and Joint Leader of the Alaskan Expeditions of 1909 and 1911


HOW WE LOST MANY HUNDRED SQUARE MILES IN ALASKA.

THIS is the narrative of the relationships of an international boundary to certain living glaciers. In the light of subsequent events it appears that the United States has lost and Canada has gained hundreds of square miles of territory. This story, in a nutshell, is that because of certain great advances and retreats of Alaskan glaciers the boundary of Alaska is located differently from similar international boundaries which are determined in relation to mountain ranges and permanent coast lines. If the portion of the boundary near Glacier Bay and Muir Glacier were to be redetermined now, Alaska would include a portion of what is British Columbia. If the boundary near Mount St. Elias and Yakutat Bay had been located early in the nineteenth century, Alaska would have included part of what is now Yukon Territory.

The boundary, however, was settled in 1903, and for all time. It is ten marine leagues, or about 35 miles, from the coast. Certain glacier fronts have had advances and recessions of 20 to 60 miles; and as these glaciers, rather than the solid land, determined the coasts, an element enters into the situation which was not considered by the Joint Boundary Commission of Great Britain and the United States.

THE ADVANCE AND RECESSION OF GLACIERS.

Most of the glaciers in the world are oscillating at the terminus, sometimes moving forward to a more advanced position, sometimes melting back. In all glaciers the ice is moving forward from the snowfield to the terminus. They terminate, however, at various elevations. Close to the equator, as at Mount Ruwenzori in Africa, the glaciers end about 14,000 feet above sea-level. In the temperate zone, as in the Glacier National Park of the Montana Rocky Mountains, the lower limit of glaciers is 6,000 to 7,000 feet above tidewater. In the Alps the Rhone glacier terminates 5,200 feet above sea level. In Alaska the larger ice tongues extend down to sea level. This is because the amount of ice removed by the melting at the end of the glacier just about equals the amount of ice which flows downward from the snowfield. Of course, there is far greater melting at low altitudes in the equatorial and temperate regions than in the Arctic and sub-Arctic lands. When forward movement and melting are just equal the end of the glacier remains at one point. Even then the ice is not stationary. It is always moving forward, because new snow is always falling in the snowfield. The glacier terminus is stationary in position, however, if forward movement just equals melting. Recession of a tidal glacier is caused by the melting of the glacier terminus plus the loss through icebergs which float away. If snowfall decreases or melting increases the balance is destroyed and the end of the glacier recedes by melting back. If snowfall increases or melting decreases the unbalanced condition results in actual forward movement of the glacier terminus. Such oscillations are always taking place. In the Alps the advance or retreat is measured in feet, in Alaska in miles. The case described below is a typical case of a great retreat in Alaska, whereby a boundary line is disturbed.

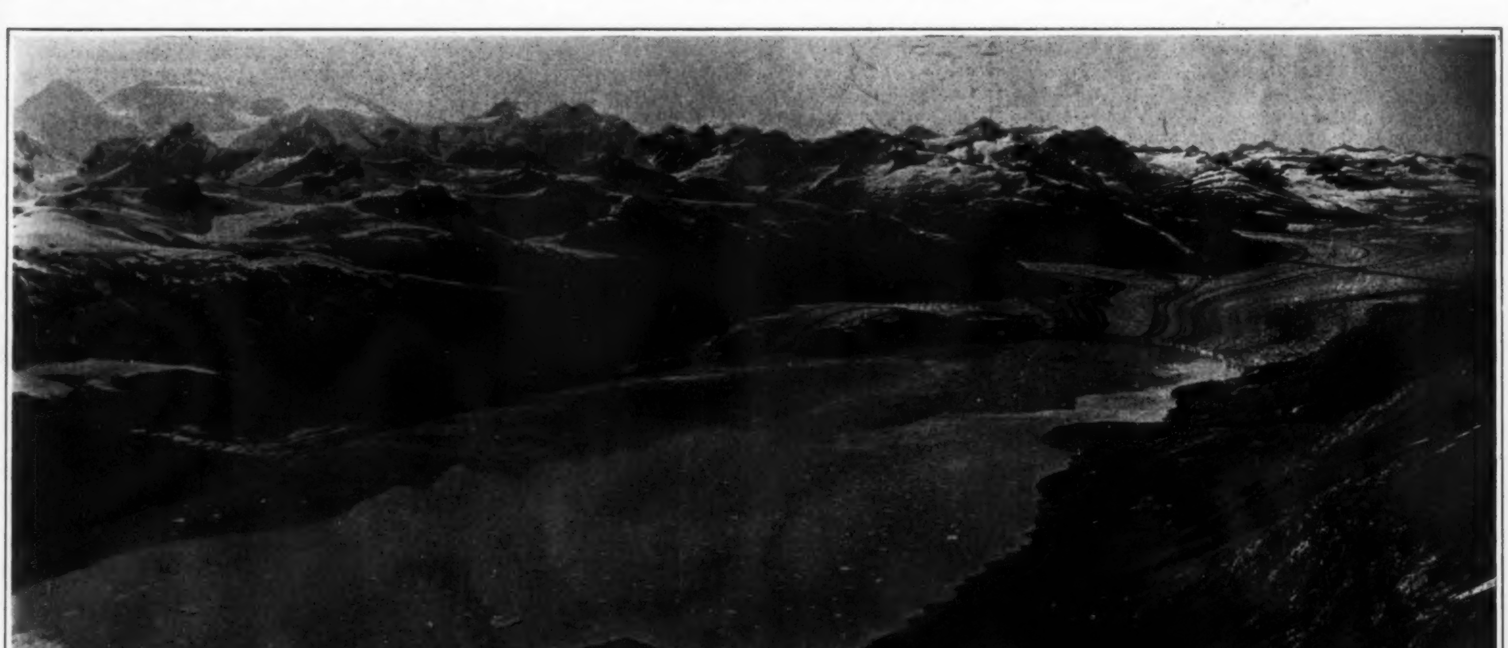
GLACIER BAY FROM 1794 TO 1912.

When Capt. George Vancouver visited southeastern Alaska in the latter part of the eighteenth century, the glaciers were at a flood stage. The fiord which we now call Glacier Bay was filled with glacier ice to within two or three miles of the mouth. About 1814, according to the natives, the great ice tongue of Glacier Bay was advancing. It pushed up a ridge of gravel in front of the glacier, overwhelmed all the trees, and advanced a mile in a very short time, thus forcing the natives to abandon their encampment on an island near the mouth of Glacier Bay. An examination of the trees in this neighborhood in 1894 by the late William Ogilvie, a Canadian boundary surveyor, tended to verify the story of the natives in all respects.

Between 1814 and 1879-80, when Glacier Bay was visited and explored by the great American naturalist, John Muir, there was a gigantic retreat of the glacier. It was dismembered into nine separate ice tongues, of which one, subsequently named Muir Glacier, had melted back 20 to 24 miles, and another, Grand Pacific Glacier, about 40 miles. A great fiord was reopened to the waters of the sea by this retreat.

From that time to the present, Glacier Bay has been frequently visited. Lamplugh, G. F. Wright, Russell, Reid, Cushing, Klotz, Gilbert, Gannett, Muir, Andrews, F. E. and C. W. Wright, Morse, Tarr, Ogilvie, and the author of this narrative having studied or mapped the

(Continued on page 136.)



Position of international boundary shown by the line on the glacier terminated north of the line in Canada, the head ing the part below sea level. By 1907 a thousand feet of the glacier, whose terminus was then 3¾ miles south of the of the Reid inlet field forming Canada's new harbor. At ice had melted away, and by 1912 the whole 1,750 feet boundary. Photograph by E. R. Martin. In August, 1912, the boundary in 1894 the ice was 1,750 feet thick, excluding of ice was gone.

**The Waning Grand Pacific Glacier and the Waxing Fiord, in 1907.**

# Installation and Care of Storage Batteries*

## Their Efficient Operation Depends on Proper Charging and Other Factors

By H. M. Nichols

Nearly every electric-generating plant, from the modest installation used for lighting summer residences to the large central stations, has its equipment of storage batteries. Some times the batteries are intended to help carry the peak load; sometimes their function is to furnish power during certain periods of the day when the demand for current is light; or they may be the chief dependence for current as in the case of private lighting plants, where the dynamo is run a few hours each day to charge the battery, which is then called upon to furnish all the current used during the evening. But no matter under which one of these heads the battery falls, it is frequently placed in some dark, inaccessible and ill-ventilated corner, and the care it receives is of the most perfunctory kind.

It is not surprising under these conditions that the battery soon begins to give trouble, and plays out in a few years, entailing a heavy expense for the replacement of plates, etc. On the other hand, if the battery is properly installed and is given the proper care the depreciation can be rendered very small.

The present discussion will first consider the layout and installation of storage batteries, then the operation and maintenance will be taken up.

The battery room should always be separated from the rest of the plant as the acid fumes are very destructive to the generating machinery, their action on the insulation of generators and wiring being particularly destructive. The fumes also corrode the switchboard connections, cable sheaths and any other exposed parts. Moreover, the fumes if breathed are poisonous and are likely to cause a very disagreeable cough. The battery room should be located as near the main switchboard as possible, thereby reducing the cost of the connecting conductors.

The walls and floor of the room should preferably be of brick or tile. If wood is used it must be protected with several coats of acid-resisting paint. Also protect all exposed metalwork in a similar manner. The floor should pitch toward a central point, having a drain connected with the sewer through a lead trap.

The room should be well lighted and ventilated and the window panes must be either ground glass or painted glass in order to keep the direct rays of the sun from striking the battery. If the sun's rays fall directly on the battery, it will cause loss of charge by local action, and also cause the electrolyte to evaporate quickly.

In the case of large installations where lead-lined tanks are used in place of glass jars, the sun's rays are not so objectionable, provided they are not directed into the top of the tanks.

In large installations exhaust fans are often provided for carrying off the acid fumes. The battery room should be so designed that the battery will not be exposed to either extreme heat or cold, and consequently it will be necessary to provide some means for heating in cold weather.

In small installations where it is not possible to have a separate room for the battery it should be housed on shelves placed against one of the walls of the generating room. These shelves should be entirely encased with close-fitting matched boards so as to form an air-tight closet. The front should be provided with large tight-fitting doors, which when opened expose the entire battery. The acid fumes are carried off to the outside through a wooden or fiber conduit. The entire inner surface of the battery closet and all exposed ironwork should be given several coats of asphaltum or other acid-proof paint. In cold localities the ventilating duct must be provided with a wooden damper which can be kept closed in cold weather except when the battery is being charged.

### SETTING UP AND CONNECTING THE CELLS.

The cells are sometimes supported by shelving along the walls, or more often by benches that rest on the floor. The shelving and benches should be shellacked and then coated with paraffin to protect them from the unavoidable acid drip and spray. Or they may be covered with asphaltum or other acid-resisting paint. In the case of large installations the tanks are sometimes set directly on the floor. In any instance the cells must be easily accessible for inspection and the replacement of plates. There should be sufficient headroom to take out the plates without removing the cells.

Care must be taken to insulate the cells from the ground as a frequent cause of trouble is due to leakage of the current over the surface of the cells and the supports to the ground. The acid fumes keep the surfaces of the cells and supports sufficiently moist to render them good conductors. Because of this danger from current leakage it is necessary to set the cells on glass or porcelain insulators. The best plan is to stand each individual cell on four insulators of the common petticoat type, since the method will prevent current leakage between the individual cells as well as between the cells and the ground.

Sometimes a double system of insulators is used. In small installations, however, where it is not desired to go to the expense of supporting each cell separately the benches on which the cells set can be insulated from the ground instead. Lead-lined tanks are usually set directly on the insulators, but sometimes glass cells are set on wooden trays that rest on the insulators. The trays are filled with sand to equalize the strain and absorb the acid drip.

The cells are usually connected in series and great care must be taken to join the positive terminal of one to the negative terminal of the next, and so on. If a mistake is made in connecting a cell it will be ruined when the charging is turned on. The best indication of the polarity of the plates is their color. The positive plates are a light brown when discharged and a chocolate color when charged, while the negative plates vary from a light to a dark gray.

Before placing the plates in the cells, carefully examine and remove any foreign substances that may have lodged between them. See that the hard-rubber insulators are properly spaced and that the positive plates do not come in contact with the negative ones. Also inspect the jars for cracks that might allow the electrolyte to leak out. The cells should be perfectly clean and the plates should clear the bottom from one to six inches, depending upon the capacity.

If the cells are filled with electrolyte before they are permanently connected together, it is a good plan to test the polarity of each cell with a low-reading voltmeter before making the permanent connections. Or the polarity can be determined by dipping wires leading from the two terminals in dilute sulphuric acid, the one from which the most bubbles of gas arise being the negative.

In small cells the connections are made by clamping or bolting the projecting lugs together. The connections should be scraped bright and clean and the bolts set up as tightly as possible. Then paint with asphaltum to prevent corrosion, and cover with okonite tape. A better method is to weld or "burn" the lugs together. If the terminals are to be burned together they should first be scraped free from dirt and oxide. A convenient scraper can be made by fastening a triangular piece of sheet steel to a suitable wooden handle. For soldering flux, use ordinary tallow. Never use acid or soldering salts, as joints made with these fluxes are likely to corrode in the course of time.

The method of welding the lugs together will, of course, depend somewhat on their size and shape. A convenient method on moderate-sized cells is to butt the two connecting lugs that are to be welded together. These lugs should be chamfered off on their top edge so as to leave a V-shaped channel where they butt together. A sheet-iron trough is then bent up having a cross-section the same as that of the terminals. This trough is then slipped over the lugs from the bottom side, is held in place with a clamp and serves to keep the molten lead in place while the lugs are being burned together.

Hydrogen gas gives the best results, but if it is not obtainable, ordinary illuminating gas may be used. If hydrogen gas is used, make sure that all of the air has been expelled from the generator before attempting to light it, since if there is any air present there is danger of an explosion. The hydrogen gas is tested for the presence of air by filling a test tube with water and inverting it in a dish of water. The test tube is then filled with gas by means of a rubber tube which is connected to the hydrogen generator, the free end being pushed up into the mouth of the test tube. As the gas fills the tube it will force out the water. When the test tube has been completely filled, remove it from the basin, keeping it inverted all the time, as hydrogen is much lighter than air, and test with a lighted match. If the gas is free from air and safe to use it will burn with a steady, almost colorless flame. If there is air present, however, the gas will explode with a sharp noise when the match is applied.

The solder should be pure lead, as tin is attacked by the acid fumes. It should be melted off the sticks and allowed to flow into the V-shaped trough between the ends of the terminals. At the same time the ends of the lugs should be kept near the melting point. Great care must be taken not to entirely melt the ends of the lugs.

Another method of connecting the terminals is to wrap a strip of lead around the terminals and put a sheet-iron mold or trough outside of this and then pour in melted lead. The lead strips must be scraped clean to insure a good joint.

The wiring for the battery room should be, preferably, lead-covered cable. If this is not used there is danger of corrosion, and liability of some of this corroded copper falling into the cells, which would be very injurious.

Care should be taken not to have any iron hooks, braces or other pieces of metal project over the cells, as there is great danger of contamination by the falling of corrroded material into the cells.

For convenience in inspecting the cells a small portable incandescent lamp may be provided. Special lamps are obtainable for this purpose which are flat so that they may be inserted into the electrolyte between the plates and the jar. This lamp should have sufficient rubber-insulated flexible cord to reach to all parts of the battery room.

The battery switchboard, which must be located outside the battery room, usually forms a panel of the main switchboard. It should be equipped with a voltmeter, ammeter and device for regulating the charging voltage. In installations where it is not convenient to regulate the charging voltage by varying the dynamo voltage, resistance boxes are used for that purpose. Or in large installations a motor-generator set may be used, this being the most efficient form of regulation.

It is also essential to provide both overload and reverse-current circuit-breakers. In case of a heavy overload or short-circuit the battery would be injured if there were no protecting devices present. In small installations inclosed fuses may be substituted for the overload circuit-breaker. The function of the reverse-current circuit-breaker is to prevent the battery current from flowing back over the charging circuit in case the generator voltage should fall below that of the battery during the charging period.

### ELECTROLYTE.

Concentrated sulphuric acid (oil of vitriol) is much too strong for use in storage batteries and it is, therefore, necessary to dilute it with water in the ratio of about five parts of water to one part of acid.

Commercial sulphuric acid will not do for battery work as it contains many impurities, such as iron, arsenic, copper, chlorine, etc. Use only chemically pure acid (symbol C.P.). The water used must be distilled as ordinary river or well water contains injurious impurities. Both water and acid should be kept in tightly-stoppered glass carboys, to prevent the introduction of impurities. If the distilled water is stored in barrels there is danger of its absorbing organic material from the barrels. Mix the electrolyte in a large earthenware or glass receptacle. Pour the acid very slowly into the water as there is considerable heat generated. *Never pour water into the strong acid*, as there is great danger of the operator being burned with the acid which will fly in all directions. *Always pour the acid into the water.*

The proper specific gravity of the electrolyte will depend somewhat on the type of battery and the purpose for which it is to be used. In ordinary stationary installations a specific gravity of 1.200 is used while in automobile and portable batteries the specific gravity goes as high as 1.300. The advantage of a high specific gravity is low resistance, but there is great danger of the plates being injured by sulphating if the gravity is run too high.

The mixture should be allowed to cool to 60 degrees, and then be brought to the proper specific gravity by the addition of a small quantity of acid or water as the case may require. Always see that the electrolyte is cool (60 degrees F.) before pouring into the cells, it being a good plan to carefully prepare the mixture twenty-four hours before it is wanted.

### TESTS FOR IMPURITIES IN ELECTROLYTE.

It is very important that the acid for making the electrolyte be chemically pure and it is recommended that each carboy of acid be tested for impurities. It is

* Reproduced from *Power*.

also a good plan to test the electrolyte in the cells once a month, as it may have been contaminated by the corrosion of iron fittings near the cells.

Copper salts also find their way into the cells in a similar manner. Nitric acid and chlorine may be present in the new plates in small quantities.

In case any impurities are found in the electrolyte it should be drawn off, the cells and plates washed out with pure water and fresh electrolyte added.

*Test for Hydrochloric Acid (Chlorine)*—To a small quantity of the diluted electrolyte add a few drops of nitric acid ($HNO_3$) and then add two or three drops of silver nitrate ($AgNO_3$). The formation of a white cloudy precipitate indicates the presence of chlorine in some form.

*Test for Nitric Acid*—A very sensitive test for nitric acid is to mix a solution of diphenylamine ($NH(C_6H_5)_2$) in concentrated sulphuric acid ($H_2SO_4$) and add it to the sample under test, the presence of nitric acid will be indicated by a blue color.

*Test for Iron*—Fill a test tube with the diluted electrolyte and heat it to the boiling point, add several drops of concentrated nitric acid ($HNO_3$) and boil again. Repeat this operation two or three times. When the solution is cold add a few drops of potassium-sulphocyanide (KCNS) which will color the solution a deep red if there is any iron present.

*Test for Copper*—To a diluted solution of the electrolyte add ammonium hydrate ($NH_4OH$ or common ammonia) until the resultant mixture gives an alkaline reaction. A deep-blue color indicates the presence of copper.

*Test for Arsenic*—To a diluted solution of the electrolyte add an equal portion of hydrogen-sulphide solution ($H_2S$). A yellow precipitate indicates the presence of arsenic.

If the electrolyte has been previously used in batteries there is likely to be a black precipitate, due to the presence of lead, and often the commercial acid contains a little lead which does no harm. In making the foregoing tests, it should be kept in mind that the reagents used must necessarily be pure or the results obtained will be unreliable. Use only those reagents that are labeled chemically pure.

The charging current should be ready to turn on as soon as the electrolyte is poured into the cells; otherwise the plates are liable to be injured by sulphating if allowed to stand in the acid without being charged. Have all connections made, cables run, etc., to avoid delay, and never under any circumstances allow the new plates to stand in the acid longer than two hours before beginning the charge. Care must be taken to see that the positive pole of the charging dynamo is connected to the positive pole of the battery as a reversal in connections would ruin the battery.

It is a good plan to test out the generator connections with a direct-current voltmeter and then make them permanent to avoid danger of their being accidentally changed. If at any time repair work is done on the generator or cables leading to the battery board, recheck the polarity, as there is always the possibility of reversal.

The first charge should be carried on for a period of 20 to 30 hours or even longer as this charge is necessary to complete the forming of the plates. The charging may be carried on at the normal rate, provided the temperature of the cells does not go above 100 deg. Fahr. If the temperature goes above this point the charging current must be reduced. It is permissible to charge at a rate lower than normal for a correspondingly longer time if it happens to be more convenient to do so.

The normal rate of charge is usually marked on the cells by the manufacturers, but it may be found by dividing the ampere-hour rating by eight. Thus for a cell the rated capacity of which is 800 ampere-hour, the normal charging rate would be 100 amperes.

The voltage required at the beginning of the charge will be about two volts per cell, and this will rise to a maximum of about 2.6 volts when the cells are fully charged. As the charging nears completion the cells will begin to gas freely, indicating that the plates have taken up nearly all the charge possible and that the surplus current is being used up in decomposing the electrolyte. At this point it is well to decrease the charging current, although moderate gassing does no particular harm other than waste energy.

When the cells are first filled with electrolyte the specific gravity will fall considerably below 1.200, due to absorption by the plates. The specific gravity will rise during the charge until it reaches slightly over 1.200 at full charge. During the ordinary operation of the cells the specific gravity when charged is about 0.025 higher than when discharged.

GENERAL CHARGING.

Always charge at the normal rate or lower except in the case of emergencies. The longest life and highest efficiency is obtained when the battery is charged slowly. During the charge the voltage rises from about 1.8 volts per cell to approximately 2.5 volts when fully charged.

As the battery becomes fully charged, bubbles of gas will be given off freely, which will give the electrolyte the appearance of boiling. Sometimes these bubbles are so fine and numerous that they give the liquid a milky-white appearance. When the battery reaches this stage it is considered fully charged, although it can be made to take up a small additional charge by reducing the strength of the charging current.

The specific gravity of the electrolyte gives another valuable indication of the amount of charge held in the cell, but it is usual practice to depend principally on the voltmeter readings.

If the battery is allowed to remain idle for any length of time, it should be given a charge every week or two to compensate for the loss of charge due to current leakage. If the battery is allowed to stand much longer than two weeks without being freshly charged, there is great danger that the plates will be injured by sulphating.

Trouble is sometimes experienced from excessive acid spray. As the battery becomes nearly charged, the gas bubbles become so numerous that the electrolyte appears to boil and these bubbles breaking at the surface throw a fine spray of acid into the air. This pray corrodes all the metal fittings that it comes in contact with and is also very irritating to breath.

Various remedies have been tried, such as having a film of oil over the electrolyte which does away with the spray, but is objectionable because it sticks to the plates when they are removed, increasing their resistance when they are replaced. Another plan is to put glass covers over the tops of the cells, but they soon collect dust which forms a conducting surface for the leakage of current. The best plan is to reduce the charging current near the end of the charge and depend on good ventilation to remove what fumes are given off.

DISCHARGING.

In ordinary practice a battery is discharged within a few hours after it has been charged. Under these conditions the battery will deliver from 75 to 80 per cent. of the energy put in during the charge. In some installations the battery is kept "floating" on the line so that it will take care of any heavy overloads and thus keep the line voltage from fluctuating. In this type of installation the battery carries a considerable percentage of full charge most of the time, as it is likely to be on discharge for only a few minutes at a time and then shift to charge as the load drops, and so on throughout the day.

If the battery is allowed to stand a week before discharging, there will be an additional loss of about 25 per cent in efficiency.

The discharge rate in amperes is usually the same as the charging rate, which is found by dividing the ampere-hour rating by 8. The battery may be discharged at a rate considerably greater than the 8-hour rate for a correspondingly shorter time. In doing this, however, a certain percentage of the capacity in ampere-hours is wasted. For example, a cell whose 8-hour discharge rate is 50 amperes may be discharged at the rate of 200 amperes for one hour, but in doing this the cell suffers a loss of 50 per cent in its ampere-hour capacity. Excessive discharge rates are injurious to most forms of cells and should be avoided.

The types of cells that use pasted plates are the most liable to injury from this cause. A battery should never be discharged below a voltage of 1.8 volts per cell, except in the case of heavy discharge for short periods. If the battery is discharged at the one-hour rate, the voltage may be allowed to fall as low as 1.6 volts per cell. If this rule is not observed the cell is very likely to be permanently injured.

Never allow the battery to stand discharged for more than two or three days, as, otherwise, its capacity is likely to be considerably lessened by "sulphating."

WEEKLY INSPECTION.

Once a week each cell in the battery should be carefully inspected and tested. With the battery fully charged, measure the voltage of each cell with a low-reading voltmeter. For this purpose a pair of prick-point leads will be found convenient. These are made by soldering a length of flexible cable to a sharp spike which is driven into a wooden handle, the cable being brought out through a hole drilled through the central axis of the handle.

With the battery fully charged also measure the specific gravity of the electrolyte in each cell. In measuring the specific gravity of the electrolyte, use a battery syringe to draw a sample for test from the lower part of the cell, as there is likely to be a slight difference in density between the top and bottom of the cell. A low specific gravity or low voltage indicates trouble of some kind which should be investigated and corrected at once. If any of the positive plates have a light color it indicates insufficient charge.

Examine the cells for short-circuits both external and internal. When sufficient sediment collects in the bottom of the cells to threaten a short-circuit, siphon off the electrolyte, which may be used again and flush out the cells with clean water.

The electrolyte should be kept at least ½ inch above the tops of the plates. Any electrolyte that is spilled or dissipated by acid spray should be replaced by electrolyte of 1.200 specific gravity. Any loss due to evaporation must be replaced by distilled water. When the cell is fully charged the specific gravity should be about 1.200. If the hydrometer shows a lower figure when the voltage of the cell and the color of the positive plates indicate full charge, dilute acid should be added to bring up the specific gravity to 1.200. Never add strong acid directly to the electrolyte in the cell.

If the specific gravity is too high add pure distilled water to the bottom of the cell with a battery syringe or rubber tube. It is necessary to add the water at the bottom as it is lighter than the electrolyte and if it was added at the top it would not mix well.

A record should be kept of the weekly inspection of the battery so that a comparison can be made from week to week of the action of each individual cell. Always take the record with the battery fully charged and also record the total battery voltage, noting any peculiar conditions of the cell and also any troubles corrected. Also record any additions of water or acid to the electrolyte to bring its specific gravity to the proper value.

LOCATING AND CORRECTING TROUBLES.

The most frequent troubles that occur in storage batteries are short-circuiting, sulphating, flaking, disintegrating of the plates, and warping of the plates.

SHORT-CIRCUITING.

A short-circuit is indicated when the voltage and specific gravity are below normal. The short-circuit may be caused by sediment collecting in the bottom of the cell or by some foreign substance falling into the cell. Cracked insulation may also cause a partial short-circuit.

A cell that has been short-circuited will require more than its usual amount of charge for some little time. This can be accomplished by charging the cell as usual but cutting it out of circuit for several discharges. This method is only practical with small cells that are connected together with bolt connectors. Another plan that does not require the disconnecting of the cell under treatment is to give it an additional charge from an outside source after the battery has been fully charged. Temporary leads can be run to the defective cell for this purpose.

SULPHATING.

A cell is said to be sulphated when a whitish scale of lead sulphate forms on the plates. This scale is a non-conductor and thus serves to insulate the active material from the plates. Any indications of sulphating should be corrected at once, for if it is allowed to continue it will not only greatly reduce the capacity of the battery but will also lead to other serious troubles.

Sulphating may be caused by overdischarging, or the battery may be left in a discharged condition for several days, even if the limit of discharge has not been exceeded. If the electrolyte is allowed to get too hot (due to an excessive discharge rate) or if it is too strong the plates are likely to sulphate. A short-circuit may also cause sulphating by discharging the cell below its proper voltage.

A cell that is badly sulphated should have the plates removed and carefully scraped until all traces of the scale have been removed. The cell should then be charged at a low rate (from one quarter to one half the normal rate) and only partially discharged. This treatment should be continued until the sulphating is entirely eliminated and the cell returns to its normal condition.

In some instances it is a good plan to add a small quantity of sodium carbonate to the electrolyte, which will help to dissolve the objectionable scale. After the scale has been removed the electrolyte should be thrown out, and the plates carefully washed to remove all traces of the soda.

FLAKING, DISINTEGRATING AND BUCKLING OF THE PLATES.

If the plates are allowed to become badly sulphated, the final result will be that the active material will peel off in large flakes. Buckling is caused by sulphate working in between the active material and the supporting grid. Flaking and buckling are also caused by excessive discharge rates and sometimes by long continued overcharge.

Flaking is objectionable because it reduces the capacity of the cell, due to the loss of active material. Buckling is likely to break up the pellets of actvie material and cause them to drop out.

Sometimes a plate that has begun to buckle can be straightened by putting it between two soft pine boards and pounding on them gently with a wooden mallet, taking care not to disturb the active material. Positive plates are more likely to be injured from these troubles, and particular attention should be given them.

# Electric Versus Gas Lighting for Motorcycles*

## Gain in Illumination, Reliability, Light Weight, and Other Factors

By L. C. Porter

THE popularity of electric lighting that has made such rapid strides on automobiles has extended to the motorcycle field. These small but speedy machines require a powerful headlight; one which is reliable and safe. Ease in manipulating the lighting unit is as much desired by the motorcyclist as by the more fully equipped autoist. It is estimated that there are now in use, in this country, some 500,000 motorcycles, and this year's production will probably increase this figure by 125,000. Many of these machines are frequently used during the evening, and most of them are at present equipped with gas lights of one form or another.

### GENERAL ADVANTAGES.

Owing to a wide difference of opinion among riders no definite rule for the requirements of the motorcyclist can be made, but many miles of riding over all kinds of roads and under various weather conditions has convinced the writer that he has a good understanding of the general requirements of a motorcyclist.

Motorcycles are driven as fast as, frequently faster than automobiles, which fact alone demands a powerful headlight for safe operation. It is necessary for the motorcyclist to see the road as clearly, and nearly as far ahead as the driver of an automobile. It is not necessary, however, for him to see so great a width of road; a headlight covering 6 to 10 feet is ample.

A machine equipped with electric lights carries with it numerous advantages which tend toward increasing the comfort of the rider. Two open gas flames, one a few feet ahead and the other a few feet back of two and one-half gallons of gasoline, are not very safe, especially in case of accident. With electric lighting, the difficulties of lighting and extinguishing are reduced to the simple turn of a switch. There is no gas tank key to lose; there are no damp matches to wrestle with or shield from the wind. Any rider who has been unfortunate enough to get a puncture on a country road at night will never forget the difficulty experienced in locating and patching the hole by what little light was thrown back of the gas headlight. With electric lighting it is a simple matter to rig up a trouble lamp which can be easily and safely moved around to any desired spot.

Electric lights also permit the use of a small speedometer lamp, electric horn, and other useful accessories—great conveniences—making night riding as satisfactory as day. With compressed gas, there is always a possibility of the tank running empty in places where it is difficult to refill it. On the other hand, there is hardly a country village where dry batteries cannot be obtained. They will operate the electric lights very satisfactorily for many hours, until a place is reached where it is convenient to recharge the storage battery.

The intensity of electric headlights remains practically constant, while to obtain the same result with gas it is necessary to keep continually opening the gas cock as the pressure decreases.

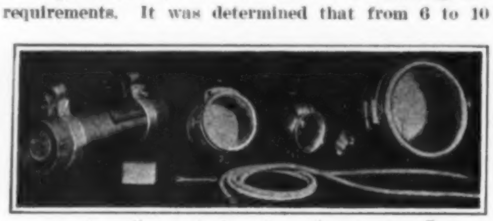
The weight of the lighting equipment is also to be considered. The lighter the machines, the less the wear on tires, etc. Figures are given later in this discussion which show that the electric equipment is lighter. No electric motorcycle lights were found on the market, but several automobile types can be easily adapted to motorcycle use. Small gas tail lamps can be easily converted into electric by replacing the gas burner with an electric lamp.

The question of current supply is one which for some time delayed the electric lighting of motorcycles. There are, however, several makes of unspillable storage batteries now on the market for this purpose. These are of two types, 4 and 6 volt. The 4-volt batteries are more compact and lighter than the 6-volt, but it is the writer's opinion that the use of a 6-volt battery is well worth the extra space and weight. It enables the use of 6-volt lamps, which can be purchased at almost any garage or electric supply house, while many of these places do not carry 4-volt lamps. One concern has an electric generator for motorcycles on the market; another is working on a combination low tension magneto and storage battery for this purpose. Storage batteries of approximately 10 ampere-hour capacity, 4 or 6-volt (preferably 6) are ample for a week's service, riding every evening, provided a little care is used and the light turned off when not in actual service. This is comparable with the service of a compressed gas tank, operating a ½ cubic foot headlight burner and a ⅛ cubic foot tail light.

* Reproduced from the *General Electric Review*.

### ROAD TESTS.

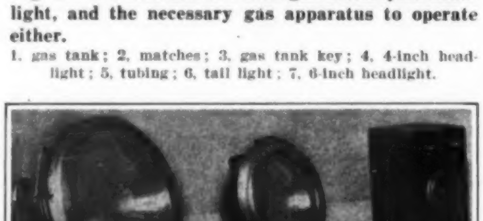
Three electric lamps of varying filament concentration but of equal candle-power were placed on the motorcycle, one at a time, and used for headlights at low and high speed, over rough and smooth roads. It was found that the lamp with extreme concentration gave too narrow a beam for satisfactory riding; the bent-back-loop filament, or one of little concentration, gave a beam which covered a great deal more of the road than was necessary; while the screw type, or auto headlight filament, came the nearest to meeting the requirements. It was determined that from 6 to 10



1 2 3 4 5 6 7

**Fig. 1.—A 4-inch and a 6-inch gas motorcycle headlight, and the necessary gas apparatus to operate either.**

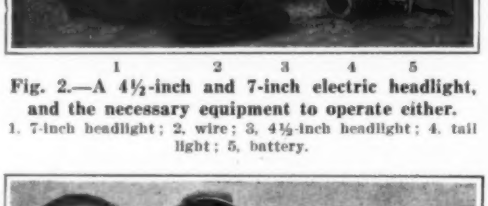
1. gas tank; 2. matches; 3. gas tank key; 4. 4-inch headlight; 5. tubing; 6. tail light; 7. 6-inch headlight.



1 2 3 4 5

**Fig. 2.—A 4½-inch and 7-inch electric headlight, and the necessary equipment to operate either.**

1. 7-inch headlight; 2. wire; 3. 4½-inch headlight; 4. tail light; 5. battery.



1 2 3 4 5

**Fig. 3.—Gas lamp ready for converting to electric —with electrical apparatus.**

1, gas burner; 2, electric socket; 3, 6-inch lamp casing; 4, mangin mirror and retaining wire; 5, parabolic reflector and bracket.

**Fig. 4.—Curves showing the difference of intensity and distribution across the center of beam, at 25 feet radius, thrown by two sizes of gas and electric headlights, using mirror reflectors.**

feet of the road should be lighted for satisfactory work. The writer also found that for the best results the center of the beam should be directed on the road 25 feet ahead of the machine.

Having determined the type of filament which gave the most satisfactory results, the next step was to determine the size of lamp necessary. In order to make a thorough study of the subject, various oil, gas and electric equipments were purchased and tried out on an Indian motorcycle under severe conditions. It was found that oil lamps were out of the question for motorcycle use. Even when mounted on the fork of the front wheel they did not give sufficient illumination for even slow riding. A well known gas lamp, consisting of a combination lamp and generator, was also tried. It was found that while the light given was sufficient for slow riding, at any speed above 10 miles an hour the beam was not powerful enough to enable the rider to discover obstacles on the road in time to avoid them. Riding on rough roads or striking a bump on an ordinary road would jar down such an excess of water into the carbide that a rush of gas would be generated so great as to make the flame roar, lose its luminosity, and endanger the mirror.

The only satisfactory gas equipment was found to be a headlight operated from compressed gas. With this equipment two sizes of headlights were used, one consisting of a 4-inch Mangin mirror back of a ¼ cubic foot burner, and the other a 6-inch Mangin mirror back of a ½ cubic foot burner. These headlights, with the necessary equipment to operate either, are shown in Fig. 1. It was found that the 4-inch headlight was satisfactory for general urban use, but when it came to high speed work on country roads, the light was hardly powerful enough to be satisfactory. The 6-inch headlight gave an excellent light; however, the flame was so far from a point source that the light spread not only over the road, but over the ditches as well. If the same volume of light could be concentrated into a beam covering but 6 or 10 feet of the road and of greater intensity, a much more satisfactory light would result. This is exactly what is accomplished by the electric headlight.

In these tests both parabolic reflectors and Mangin mirrors were used. Lamps of 2, 4, 6, 8, 10, and 16 candle-power were tried. It was found that for slow riding, 2 candle-power lamps furnished sufficient light. For rough roads or high speed work, the 8 candle-power lamps were found to be amply powerful. For general use, the best lamp was found to be 6 candle-power.

There are many gas headlights in use on motorcycles to-day. In order to determine the possibility of converting these into satisfactory electric lamps, the gas burners in two gas lamps (one equipped with a 4-inch and the other with a 6-inch Mangin mirror) were replaced by lamp sockets. The 6 candle-power screw type filament lamp was used in each case. It was found that with this lamp located at the focus of the reflector, a very powerful but very narrow beam was obtained—one which was too narrow for safe riding. When the lamp was located between the focal point and the mirror, a good spread was obtained, but there was a dark spot in the center of the beam. When, however, the lamp was located a short distance ahead of the focus, a very satisfactory beam was obtained. With both the 4-inch and the 6-inch headlights, beams were obtained which were decidedly better than the gas beams. They were more powerful, and while not having so great a spread, were sufficient for comfortable riding, at the same time being very steady. The 4-inch headlight was found to be sufficiently powerful for ordinary use, but as with the gas, the 6-inch light was required for high speed or rough roads.

A search was made for an electric headlight for a motorcycle, but none was found. However, two electric headlight lamps were obtained from automobile apparatus. One consisted of a 7-inch parabolic reflector and casing, used as a small auto headlight; the other of a 5¼-inch reflector (only 4½-inch being effective, due to the door covering the edge of the reflector) used for an auto sidelight. Both of these headlights are illustrated in Fig. 2. The 7-inch reflector equipped with the 6 candle-power lamp mentioned above made a most excellent headlight. It was much more powerful than the 6-inch gas lamp and had ample spread; in fact, this lamp was more powerful than necessary. Equipped with a 2 candle-power lamp, it gave very good light, as did also the converted side lamp.

One prominent manufacturer makes a 6-inch parabolic reflector complete with bracket and lamp socket for converting gas to electric light. This is illustrated in Fig. 3, together with the other parts involved in the conversion. Gas headlights having a 6-inch or larger mirror can be converted to excellent electric headlights by removing the gas burner and mirror, and replacing them with this reflector. This can be done in a few minutes with a pair of pliers. The gas burner is removed from the casing by simply unscrewing the base unit. The mirror is removed by pulling out the piece of stiff spring brass wire shown in Fig. 3. The reflector and bracket can then be inserted and held in a simi-

lar manner to the old gas burner. If the rider does not care to purchase the reflector outfit, however, the gas burner can be replaced by an electric socket, obtainable at almost any auto supply house. Such a socket is shown in front of the lamp casing in Fig. 3.

LABORATORY TESTS.

In order to obtain some comparative figures on gas and electric lighting for motorcycles, photometer tests were conducted on both. The gas lamps used were equipped with a 6-inch Mangin mirror and ½ cubic foot burner and a 4-inch Mangin mirror and ¼ cubic foot burner. Acetylene gas was supplied to these lamps from a compressed gas tank. The flame was turned up as high as it would go without roaring.

The candle-power of the two gas burners alone was measured and then distribution curves were taken. An examination of the data and curves *A* and *C*, Fig. 4, shows that the candle-power of the ½ cubic foot burner is 18, while that of the ¼ cubic foot burner is 8. The distribution across the beam at 25 feet shows wide spread with maximum intensities of 1.03 and 0.56 foot-candles. The curves show that the beams are a little uneven. After these, curves were taken from the headlights with the gas burners replaced by the 6 candle-power tungsten lamp. The lamp was thrown sufficiently far ahead of the focal point to give good spread. These curves, *B* and *D*, Fig. 4, show that the beam thus obtained is even, and while the spread is not so great as the gas, the beam covers a sufficient amount of the road for safe riding and has a higher intensity than the gas in the center, i. e., directly in front of the motorcycle reaching 1.3 and 0.92 foot-candles.

In order to determine the intensity of light that would be thrown on a stone, the side of a hole, or other obstruction in the road at various distances ahead of the machine, photometer readings were taken on a plane 38 inches below the headlight (the height of the light above the ground when mounted on motorcycle handlebars) with the center of the beam directed on the ground 25 feet ahead of the light. These readings, curves *A* and *C*, Fig. 5, show the normal illumination on an obstruction in the road, from 5 to 50 feet directly in front of the machine.

Next, similar tests were conducted on the two sizes of electric headlights, each being a parabolic reflector equipped with a 6 candle-power tungsten lamp, one having an effective surface 7 inches in diameter, and the other 4½ inches. Curves *A* and *B*, Fig. 6, show that the 7-inch lamp has a spread (6 to 10 feet) sufficiently great for satisfactory riding and throws a beam of nearly five times the intensity of the 6-inch gas or 6-inch gas converted to electric. The 4½-inch electric lamp also has good spread, and is more powerful than the small gas or gas converted lamp.

Photographs which were taken of the road illumination given by various gas and electric equipments, are shown in Figs. 7, 8 and 9.

The weights of the various apparatus were found to be as follows:

GAS.

| | | |
|---|---|---|
| 6-inch gas headlight and brackets | 4 lb. | 13½ oz. |
| 4-inch gas headlight and brackets | 2 lb. | 7 oz. |
| Tail lamp and brackets | | 11½ oz. |
| Compressed gas tank | 9 lb. | 13½ oz. |
| Rubber tubing | | 5 oz. |
| Gas tank key | | ¾ oz. |
| Total with 6-inch lamp | 15 lb. | 12¼ oz. |
| Total with 4-inch lamp | 13 lb. | 6 oz. |

ELECTRIC.

| | | |
|---|---|---|
| 7-inch headlight and brackets | 4 lb. | 6 oz. |
| 4½-inch headlight and brackets | 3 lb. | 10 oz. |
| Tail lamp and brackets | | 5 oz. |
| 6-volt, 10 ampere-hour battery | 11½ lb. | |
| 4-volt, 10 ampere-hour battery | 7 lb. | 9 oz. |
| Wire | | 4 oz. |
| Switch | | 4 oz. |
| Total with 7-inch lamp and 6-volt battery | 16 lb. | 8 oz. |
| Total with 7-inch lamp and 4-volt battery | 12 lb. | 9 oz. |
| Total with 4½-inch lamp and 6-volt battery | 15 lb. | 12 oz. |
| Total with 4½-inch lamp and 4-volt battery | 11 lb. | 13 oz. |

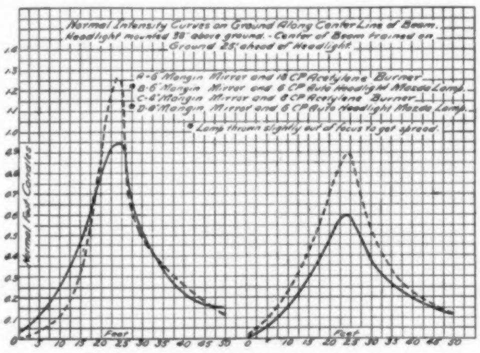
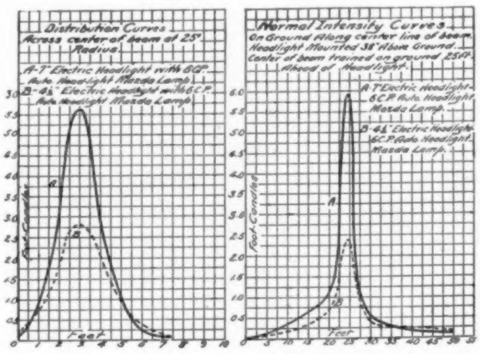



**Fig. 5.—Curves of normal intensity on ground along center line of beam from two sizes of gas and electric headlights using mirror reflectors.**
*A*, full line curve; *B*, dotted curve; *C*, full line curve; *D*, dotted curve.




Distribution curves across center of beam at 25 ft. radius

Normal intensity curves on ground along center line of beam

**Fig. 6.—Curves showing characteristics of beam projected from a 7-inch and a 4½-inch electric headlight, employing parabolic reflectors.**

The space occupied by the various equipments was also measured, and found to be considerably less for the electric outfit, the storage battery occupying about one half the space required by the gas tank. The headlight occupied nearly the same space; the electric tail light considerably less.

CONCLUSIONS.

As a result of the tests, the writer draws the following conclusions: Electric lighting is very satisfactory; it enables the user to obtain a powerful headlight, giving a steady beam, no matter how rough the road; the beam does not fall in intensity, as does that of a gas lamp, which requires continual opening of the valve; no matches are required, and there is no gas tank key to lose; the lamp can be easily focused to give a long, powerful beam for country use, or a wide spread at lower intensity in the city. Electric lighting can be controlled by the simple turning of a switch; it enables the use of a small tail lamp, a speedometer lamp, and a trouble lamp, the latter being of great service; it enables the use of a small electric horn; the storage battery can, if necessary on a long trip, be temporarily replaced by dry batteries, which are obtainable anywhere.

The operation of electric lighting is very much more convenient than that of gas. The space occupied is less, meaning a neater equipment. Very satisfactory electric outfits can be obtained with little trouble, and but slight expense where gas is now in use, by simply replacing the gas headlight burner with a 6 candle-power electric lamp and socket, the gas tail light burner with a ½ candle-power tungsten, and the gas tank by a small storage battery. Where new outfits are purchased even more powerful headlight lamps can be obtained.

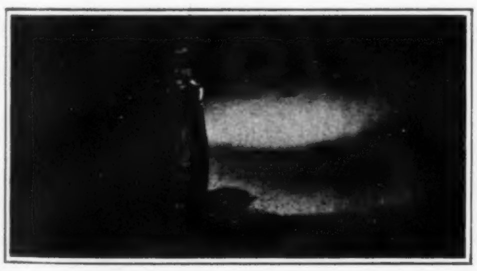


**Fig. 7.—Illumination given by a 6-inch gas headlight, showing stones a distance of 25 and 50 feet ahead.**

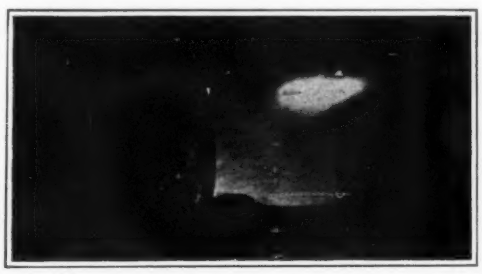


**Fig. 8.—Illumination given by a 6-inch gas headlight converted to electric, showing stones 25, 50 and 100 feet ahead.**

**Fig. 9.—Illumination given by a 7-inch electric headlight, showing stones 25, 50, 100 and 200 feet ahead.**

# Artificial Daylight for Color Matching

## The Requisite Components of Light Sorted Out by Means of Light Filters

By Robert French Pierce

WHEREVER discrimination between or matching of colors is necessary, deceiving and sometimes almost unbelievable errors are apt to be introduced by the light in which the colors are viewed. Not only do all the artificial lights, no matter how white they may appear to the eye, distort colors from their so-called "daylight" values, but the north-sky itself, the most uniform of natural light sources, is notoriously unreliable.

A match made under a cloudless north-sky may, with some delicate colors, prove far from a match under a cloudy sky. Furthermore, the modifications of north-skylight introduced by reflection from green foliage, red brick buildings, etc., often prove so deceptive that a match made in one portion of a plant may not be duplicated in another. This deficiency in natural light is perhaps best understood, because most plainly in evidence in the dyeing of textiles in which delicate and complex dyes are used, but lithographers, engravers, printers, color grinders, paper makers, etc., often find that even with the less sensitive mineral pigments, the sky is by no means a dependable light source for color matching.

No less frequently is the purchaser of dress goods, printed matter, stains, paints, etc., disappointed over the results of matching samples under artificial light, or under daylight distorted by reflections from surrounding buildings, etc.

While it is true that not all fabrics or colored objects are to be worn or displayed under daylight or even under approximately white light, it is obvious that matching may be best done under the particular kind of light originally used by the dyer or color maker. Subsequent estimates of the appearance of the fabric or object under any artificial light may be made under the particular light required, but this operation is far more deceptive than is usually supposed. For instance, it might be thought that material for a ball-gown might well be matched under electric incandescent light, but if the match be made under tungsten lamps in a store, and the gown be worn in a ball-room lighted by small low efficiency carbon filament lamps, such as are often used for decorative or artistic lighting effects, the result is apt to be anything but pleasing.

Since manufacturer, retailer and user of fabrics and materials in which color is an important feature have long suffered from the lack of an artificial light duplicating daylight and at the same time

eliminating its unreliability from the standpoint of color, it is believed that a description of a new and successful solution of this problem will prove interesting.

The color of a fabric or other material as apparent to the eye, depends upon two things: The composition of the light by which it is illuminated, and the property of the material itself of absorbing light rays of certain colors.

The latter may be controlled by the use of paints, dyes, etc., but these only serve to cause the material to display the same hue under light of the same composition.

It should be clearly understood that it is the *composition*, not the color alone of the light that is of importance. Similarity of color does not necessarily imply similarity of composition. For instance, the composition of sunlight or white light from the calcium light or the open electric arc is quite different from that of white light made by the mixture of red, green and blue light.

If we split sunlight up into its component parts or spectrum (Fig. 1) by means of a glass prism, we see that this spectrum is a continuous band containing six colors, violet, blue, green, yellow, orange, and red, each shading almost imperceptibly into the adjacent ones. If, however, we split up in the same manner, a white light made by mixing red, green and blue light, we obtain the spectrum shown in Fig. 2, containing only three narrow lines. If sunlight be thrown upon a surface which absorbs red rays only, the spectrum of the reflected light will be identical with that of the original light, except that the red portion will be lacking (Fig. 3). If the same surface be illuminated by a white light made by mixing red, green and blue light, the resulting spectrum will contain only the narrow blue and green bands (Fig. 4). Since it is the composition of the light entering the eye that determines the color perceived, it is possible for a fabric to appear of one color under one kind of white light, and of quite another color under a white light of different composition.

To match colors under artificial light so that they will also match under daylight, it is necessary to provide artificial light having the same composition as daylight.

No ordinary commercial source of artificial light produces a light even remotely approaching daylight in composition. This may be readily seen from Fig. 5, which shows the distribution in different portions of the spectrum of light from several well-known artificial light sources. The incandescent gas lamp, the incandescent electric lamp, and the acetylene flame contain all the colors found in daylight, but in vastly different proportions. Others, like the mercury vapor lamp, emit light containing but one or two colors. As practically an infinite number of color gradations or shades are present in daylight, the duplication of daylight by mixing together various colors of light separately produced, is quite impracticable.

The other expedient is to utilize some artificial light containing all the colors present in daylight, absorbing or filtering out the excess of different colors *above* the proportions in which they are found in daylight, so that the remaining light will be an exact duplication of daylight in composition and hence in effect.

It would appear from the curve that only say 80 per cent of the light from the Welsbach mantle would thus require absorption to bring the remainder to daylight composition. It is not possible, however, to absorb the excessive or undesirable rays alone without also absorbing a certain portion of the rays in which the light is already deficient, and for this reason the practical use of this method involves a sacrifice of 90 per cent of the total light produced. With other artificial light sources, however, even a greater proportion must be wasted, so that the Welsbach mantle is by a large margin the most economical means of producing artificial daylight.

The light from both incandescent electric lamps and incandescent gas lamps varies considerably in composition according to the material used. In the gas mantle particularly light ranging in


**Fig. 1.—The continuous spectrum of sunlight, with its six principal colors: violet, blue, green, yellow, orange, and red.**


**Fig. 2.—Spectrum of "white" light produced by mixing blue, green, and red.**


**Fig. 3.—Spectrum of sunlight reflected from a surface which absorbs only red light.**

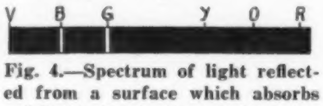



**Fig. 4.—Spectrum of light reflected from a surface which absorbs red light, the incident light being "white," composed of red, green, and blue.**

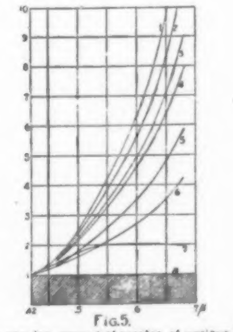


Fig. 5.

Curves showing amount of spectra of various light sources which must be absorbed to give white light. Shaded area - White Light.

1. Glow lamp, carbon 4.85 watts per MSCP.
2. " " " 3.75 " " "
3. " " metallized 3.1 " " "
4. " " tantalum 2.6 " " "
5. " " tungsten 1.58 " " "
6. Acetylene
7. Welsbach mantle 3/4 % cerium
8. Daylight

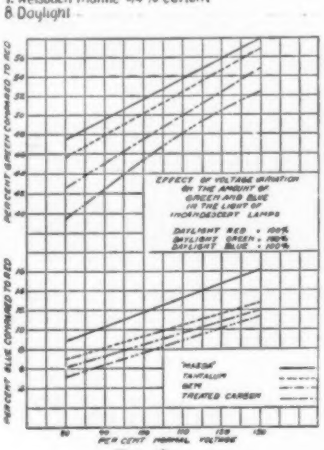



Fig. 6.

color from purple at one end of the spectrum to red at the other may be obtained by varying the proportion of ceria. The efficiency of light production varies at the same time.

Since all absorbing screens which filter out the excessive amounts of red, orange, and yellow rays also absorb to some extent the blue and violet rays in which the artificial light is already deficient, it is desirable to start with as close an approach to daylight as possible, thus reducing the amount of absorption necessary and conserving the small amount of blue and violet light present in the original light. Colored screens for absorbing different colors of light may be made of properly colored glass, or of clear colorless glass bearing a film of gelatine containing properly selected dyes. Colored glass is almost impossible to secure of sufficiently uniform thickness and quality. On the other hand, no dyes available will absorb or filter out the long dark red rays which are present in great excess, while certain blue-green glasses perform this service very effectively.

The best results are therefore secured by first filtering the light through a screen of blue-green glass to remove the excess of long red rays, and then passing it through a second filter of dyed gelatin carried on a plate of colorless glass to remove the excess of other rays remaining. Since the composition and density of the dyed gelatine film is easily controlled, exact correction may be made for any non-uniformity in the blue-green glass screen with which it is "paired." This "pairing" is performed by spectro-photometric analysis of the light passing through the two screens, and comparison with the spectral distribution of average daylight as previously determined. The resulting light is identical with *average* daylight. It is only by means of these highly refined methods that a reliable and uniform light for color-matching may be produced.

The first successful practical application of the absorption method of producing artificial daylight was made by Dr. H. E. Ives, who carried the difficult and laborious research and experimental work upon which the solution of the problem depended to a commercially satisfactory conclusion. The results of his early experiments were embodied in practical form a few years ago in an artificial daylight producer utilizing the tungsten lamp as the original light source. Later research indicated the possibility of a closer approach to average daylight than was obtained with the earlier device, and the results of his recent investigations have been applied to the construction of a device in which the faults of the earlier apparatus are eliminated, and which may be used either with the Welsbach gas lamp or with the tungsten electric lamp, the only difference being in the dyes used upon the second screen.

The gas mantle is preferable to the electric source, however, since the light from the latter changes in composition with burning and with different voltages while the gas lamp suffers no changes of a corresponding nature. Fig. 6 shows the variation in the proportions of green and blue light, respectively (with relation to the red), under different voltages. As voltage fluctuations frequently occur on electric lighting circuits, a variation in the quality of the resultant light is encountered.

The Welsbach mantle is of a special composition which maintains a uniformity in the color of light emitted throughout life and is in itself a much nearer approach to daylight than any other artificial incandescent light source. This reduces the loss of light through absorption, a very important matter, since even with this mantle, it is necessary to absorb 90 per cent of the original light. Since the resulting artificial daylight is comparatively expensive at best, the desirability of utilizing economical light sources with which the least loss through absorption is attended, is obvious.

A further advantage of the use of the Welsbach mantle lies in the fact that different mantles may be furnished, which in the same apparatus enables an exact duplication of either average north skylight or direct sunlight. By this means the variation in hue or match between these two extremes of daylight may be determined without dependence upon outside weather conditions.

## The Earth's Poles*

All the points in and on the earthly sphere must move together in such a way that their relative positions are not changed nor the sphere distorted. Hence, while they all have the same angular speed about the axis—that is, they all run the circuit of their own circles in the same time—their linear speed, their miles per hour, must depend upon their distance from the axis. Thus at the equator every point moves about 24,000 miles in twenty-four hours; that is, about a thousand miles an hour. Omaha is about 6,000 miles from the earth's axis and rotates, therefore, at the rate of about 750 miles an hour. As the poles are on the axis itself they do not rotate at all; their linear speed is zero.

The consequence of this immobility is a total loss of the so-called centrifugal force. This force is the apparent tendency of a point to recede from the center of revolution; it is in reality a case of inertia, according to which it tends to retain its direction and remain on the tangent line.

At the equator this tendency is a maximum and amounts to 1-289th of the gravitational attraction. So that the weight of bodies is lessened there by one pound out of every 289. As a consequence the movable constituents of the earth's surface, the air and water, have receded from the axis and approached the equator, and have there accumulated in a ring around the latter thirteen miles thick. The equatorial radius of the earth is therefore thirteen miles longer than the polar radius. This difference between the radii of different parts of the earth's surface is a gradual one. The polar radii are the shortest, and the rest increase in length gradually until we reach the equator.

The poles of the earth are, therefore, unique in two respects—they do not rotate and they are nearer the earth's center than the other parts of the surface. For both reasons the weight of bodies is a maximum at the poles. It is one pound out of every 190 greater than at the equator.

* Extract from an article by W. F. Rigge, published in the *Creighton Courier*.

# The Hempstead to Washington Flight

The monoplane in which C. Murvin Wood made his flight from Hempstead, L. I., to Gaithersburg, Md., on August 8th, as described in the Scientific American of August 16th, is novel in several respects. The photograph reproduced herewith, which was taken at Gaithersburg, where the machine alighted, by our aeronautic contributor, gives a good idea of the appearance of the front of the aeroplane and its chassis. The most noticeable feature is the Blériot type frame and chassis which has been lowered by the designer, and also inclined backward till it rests at a considerable angle with the vertical when the machine is on the ground. The ordinary Blériot design places the top cross member of the front frame level with the top of the fuselage, and Blériot himself has tried placing this member below the latter, thus shortening the height of the frame by about one-half. The designer's idea of inclining the frame, and thus bringing the wheels farther forward so as to make the machine less likely to stand on its nose when running over the ground, is a good one, and it works out well in practice. The front frame can be more substantially braced also, which is an advantage in case of collision with any object.

The disk wheels used minimize air resistance as does also the curved hood that covers the motor but which was removed before the photograph was taken. Hand holes are provided in the metal side plates at the front of the fuselage for the purpose of getting at the tanks, etc. Single V-shaped struts above and below the body support the guys and warping wires. A Farman control lever, mounted on a universal joint, is employed, steering being accomplished by a foot tiller as usual. An original Blériot type tail is fitted at the end of the tapering, covered fuselage. This tail appears to be very small and light, but it is said to be strongly constructed. It consists of two stationary central surfaces (one on each side of the body) 22 inches wide by 32 inches long, flanked on each side by movable elevator surfaces 32 inches square. Both the tail and elevators are flat on both sides and the former is set at so slight an angle that it is practically non-lifting and serves merely to stabilize. It is built as a unit with a box girder construction that stiffens it and that carries the movable, wood-stuffed steel tube on which the elevators are mounted. So staunchly is the tail constructed that no braces are necessary. It is attached to the fuselage by two U-shaped bolts. The vertical rudder is placed at the end of the fuselage (the top and bottom sides of which meet at this point) and it can swing through an angle of about 30 degrees only on each side of the center line and between the two tail surfaces. The end of the body is braced by a V-shaped strut to the end of a curved skid beneath it.

The wings of this new monoplane are nearly flat, as it is intended for dispatch carrying. They are 14 by 6 feet near the body, tapering to 5⅝ feet at the tips. A piece 10 inches wide by 24 inches long is taken out of each wing at the inner rear edge so as to afford a view directly beneath him if the aviator turns in his seat and looks down. It is because of this that the wing appears to be so narrow in the photograph. The spread of the wings is 30 feet, and the length over all of the machine is 21 feet, the body being only 17 feet long. A 50 horse-power Gnome motor, carrying an 8-foot tractor screw with a pitch of 5¼ feet, is fitted. This will drive the machine about 70 miles an hour.

After testing the machine very thoroughly at the aerodrome at Hempstead, L. I., Aviator Wood made a flight from that field to Fort Myer, Va., on August 8th. He started at 4:30 A. M. and followed the railroad to Belmont Park. Then, constantly rising, he bore to his left and soared above the fog. His motor stopped and he descended some 2,000 feet and saw the Atlantic Ocean beneath him before the motor picked up again. Turning to his right, Wood flew for 10 minutes before he came over land at Coney Island. He crossed New York Bay and Staten Island and finally came above the main land at New Brunswick, N. J. He flew around Trenton, Philadelphia, and Baltimore. His highest elevation—7,225 feet—was attained at Havre de Grace, Md., 20 miles north of Baltimore. From then on he kept losing height because of the frequent stopping of the motor. He also lost the railroad tracks in passing around Baltimore, and flew too far to the westward. He finally was obliged to land because of ignition trouble, but after his motor had been overhauled, he completed his flight and arrived at Fort Myer at 5:45 P. M. His time was 4 hours and 31 minutes for the 239-mile non-stop flight to Gaithersburg, and he was about a quarter of an hour longer completing the journey. He would probably have reached Fort Myer in the morning before he was forced to descend had he been able to keep in view of the Railroad tracks, and thus maintain his course. His flight was marred only by the failure of the motor. After his arrival at Fort Myer he made a number of demonstration flights for the army officers, who were well pleased with his machine.



**C. M. Wood in his "Bluebird" monoplane at Gaithersburg, Va.**

This photograph was taken at the end of Wood's 4-hour 31-minute flight. His mechanic is seen working at the motor after removing the hood (seen at the left).

## The Vogue of Special Steels

At the close of the last century, and indeed in the earliest years of the present century, the quantity of special steels made was almost negligible. There were virtually but two kinds, ordinary soft steel and rail carbon steel. At that time there were buyers, though only a few, who desired steel of special composition and these generally met with cold reception from steel makers when they undertook to make their wants known. Steel makers were just emerging from that fierce struggle for tonnage which made the decade of the nineties memorable, and they regarded all proposed variations or irregularities as a foe to progress.

To this indifference, if not antagonism, to the supposed wants of some buyers there succeeded with striking rapidity an era of competition among steel producers, with the result that in place of turning a deaf ear to the pleas of buyers that modifications in the character of steel would aid them in accomplishing better results, the producer sought out the consumer at the place where he used the steel, and undertook to co-operate in finding means whereby steel could be made more adapted to special requirements. Quickly the producers found that steel could be adapted better to certain uses and that its sale could be pushed in many quarters.

Immense service has been rendered by these investigations. As making two blades of grass grow where only one grew before represents a valuable result, so making one pound of steel perform well a service for which two pounds had formerly been required, and then perhaps with indifferent results, has aided in the development of the industry. It is strongly to be suspected that in the benighted days of a decade or more ago there lurked among some producers an antagonism to such progress, engendered by the fear that thereby the consumption of steel would be reduced.

The suggestion that the development of special steels along the line of making a less weight of steel perform the desired result is not applicable to much of the development that has thus far occurred, but herein we may find the prophecy that development in the future may be still more strongly along that line. Much of the work done in special steel has been along the line rather of increasing the efficiency of the finished product made from the steel, or of prolonging its life. In the case of the special sheet steels used in the electrical industry, for instance, the result has been to increase the efficiency of the finished apparatus. In the development of special steel for automobile construction the result most important has been to prolong the life of the part. In each of these cases reduction in weight has been an important incident, but not the principal desideratum.

In the production of steel for many forming purposes, again, the object has been chiefly to reduce failures. Taking the run of steel, some steel failed and some did not, and users were not content with a condition in which pieces of steel apparently similar did not all produce prime product. The percentage of failures, even if small, presented an item of loss which deserved study.

To return to the suggestion of reducing the weight of a piece of steel without reducing the service it performs, the fact seems to be that relatively little progress has been made, when compared with the great advance scored in the manufacture of steel sheets to perform certain electrical service, of steel for automobile and other parts to withstand repeated stresses or of steel to undergo difficult forming operations. By far the major portion of steel used in the form of merchant steel bars, of plates and of structural shapes, remains practically simply ordinary soft steel. For this absence of change one specific reason of interest can be vouchsafed, and that is that there are what may be termed structural difficulties in the way of saving material by improving certain physical characteristics—the tensile strength, for instance. Thus a tank, while it must withstand a certain pressure, in which tensile strength simply is involved, must also be of certain stiffness, to prevent collapse through its weight. By increasing tensile strength the pressure could be borne with less thickness of plate, but the stiffness would be reduced. Such a problem must not be regarded as insoluble; the engineer may be able to co-operate with the metallurgist and by modifying the design produce the requisite stiffness when using thinner plates of greater tensile strength. The illustration here used may be crude, but should suggest a principle upon which development may occur.

The constantly increasing size of bridges and buildings is rapidly bringing forward the need for stronger steel, because the weight of the structure as erected is more and more exceeding the load which it is destined to bear. The bridge on a country road, which consists of two beams with planks laid across, will support a load many times its own weight; but when the St. Lawrence River or Hell Gate is to be bridged, the chief function of the structure is to support its own weight. The load to be borne is relatively little more than an incident. In a building, there is a theoretical limit of height at which a given steel would crush of its own weight, while in a suspended cable there is a limit of length at which it will part from its own weight.

Since no limit can be found as to the size to which man may wish to push some of his structures, so we are tending to a time when strength in proportion to weight will be the governing element, and then in certain cases stronger steel will be neither a convenience nor an economy; it will be a necessity. Thus while attention may well be directed to the rapidity with which special steels have been developed, bringing on a new era in steel manufacture, it becomes obvious that indefinitely greater progress is still to be made.—*The Iron Age.*

**How glaciers move forward.**

Two photographs from exactly the same point, showing a small cascading glacier in Rendu Inlet, 1907 and 1911. Upper view by Netland. The advance amounted to about thirteen hundred feet.

## Glaciers and International Boundaries

*(Continued from first page)*

glaciers at various times between 1884 and 1912.

By 1894 the retreat of Muir Glacier, in the eighty years since 1814, had attained over 25 miles, while Grand Pacific Glacier had receded 44 miles. This data is of interest because the portion of the Canada-Alaska boundary near Glacier Bay was settled by treaty in 1903 and subsequently demarked upon the basis of the positions of the glacier termini in 1894. From 1894 to 1911 Muir Glacier retreated nine miles and Grand Pacific Glacier ten miles. In the nine months between the visit of the author to Glacier Bay, on a National Geographic Society expedition in company with the late R. S. Tarr of Cornell University, in September, 1911, and the visit of N. J. Ogilvie of the Canadian Boundary Survey on June 1st, 1912, the Grand Pacific Glacier melted back ¼ to ¾ mile, and in the following two months it melted 1¼ miles more, making at least 1½ miles of glacier retreat and 1½ miles of increase in length of the fiord in less than a year. Thus we have a recession of about 60 miles from 1814 to 1912, 16 miles of this distance in the period of recent visits following that of Muir in 1879, and about 12 miles since 1894. Think of it! The great Hardanger Fiord south of Bergen, in Norway, is only about 60 miles long. The fiord called Glacier Bay, in Alaska, has been entirely revealed by the glacier recession of 60 miles in the 118 years since 1794.

**Nine to ten miles of retreat of Grand Pacific Glacier from 1894 to 1907.**

Two photographs from exactly the same point, by A. J. Brakason and by E. R. Martin. The Grand Pacific Glacier is the one in the right background with the International Boundary shown by a line on its surface.

**In the domain of glaciers.**

The snowfields of Mount Fairweather, 15,330 feet, with the glaciers of the mountain slopes and the iceberg-dotted waters of Reid inlet in Glacier Bay, Alaska, in 1911.

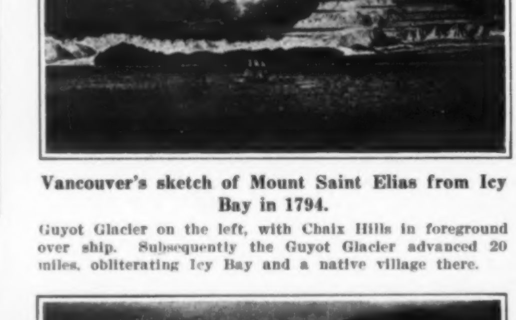
### GRAND PACIFIC GLACIER AND THE INTERNATIONAL BOUNDARY.

The international boundary crosses the valley occupied by Grand Pacific Glacier about 12 miles northwest of the ice front of 1894. Here a portion of the boundary line was placed less than 35 statute miles from the supposed head of the bay. This was probably in order to run it in a direct line to Mt. Fairweather, which was desired as a boundary peak. It is certain that this portion of the boundary was not located in the expectation of such a great retreat of Grand Pacific Glacier as has since taken place.

On August 1st, 1912, the Grand Pacific Glacier had receded so far that its terminus was in British Columbia rather than in Alaska, and Canada had acquired a new harbor. At this point the glacier surface rose 1,750 feet above the sea level in 1894, but had melted down to 750 feet in 1907, and had all disappeared in 1912. A retreating glacier loses ice not only by melting and iceberg discharge at the glacier front, but also by vertical ablation of the glacier surface, as in this case of downward melting of 1,750 feet in 18 years.

This new seaport lies in a snowy desert land and is reached only by traversing American waters; but, in the spirit of the original treaty, Canada should have no harbor whatever in this region. The international boundary is now fixed and, of course, will not be changed merely because the terminus of a tidal glacier was accepted as the head of a bay and the bay was later enlarged by retrogression of its head. If the boundary had been adjudicated soon after Vancouver made his map in 1794, with the Muir ice front 34 miles and the Grand Pacific ice front 60 miles from its 1912 position, Canada would have gained hundreds of square miles of territory. If the boundary were under treaty in 1912 with Grand Pacific Glacier 15 or 16 miles back from which it was in 1879, nearly 12 miles from where it was when considered by the boundary commission, and about 60 miles from the probable end in 1794, then Alaska would gain hundreds of square miles. Evidently a glacier is too variable a feature to be used in determining an international boundary.

Moreover, there are advances as well as retreats in the Alaskan glaciers, and Canada's newly gained harbor will eventually be lost again through advance of the glacier. This we know from the ancient and modern advances of ice tongues in this very region.



**Vancouver's sketch of Mount Saint Elias from Icy Bay in 1794.**

Guyot Glacier on the left, with Chaix Hills in foreground over ship. Subsequently the Guyot Glacier advanced 20 miles, obliterating Icy Bay and a native village there.

**Exhumed stump near Muir Glacier.**

This photograph was taken in 1911. In 1890 the ice was moving over this very spot at the rate of 5 to 7 feet a day.

**How glaciers melt back.**

Two photographs from exactly the same point in Glacier Bay, showing the Charpentier Glacier in 1899 and in 1911. Upper photograph by G. K. Gilbert. The recession by melting of the glacier terminus and iceberg discharge amounted to over 2½ miles in 12 years.

### A MODERN ADVANCE OF A GLACIER.

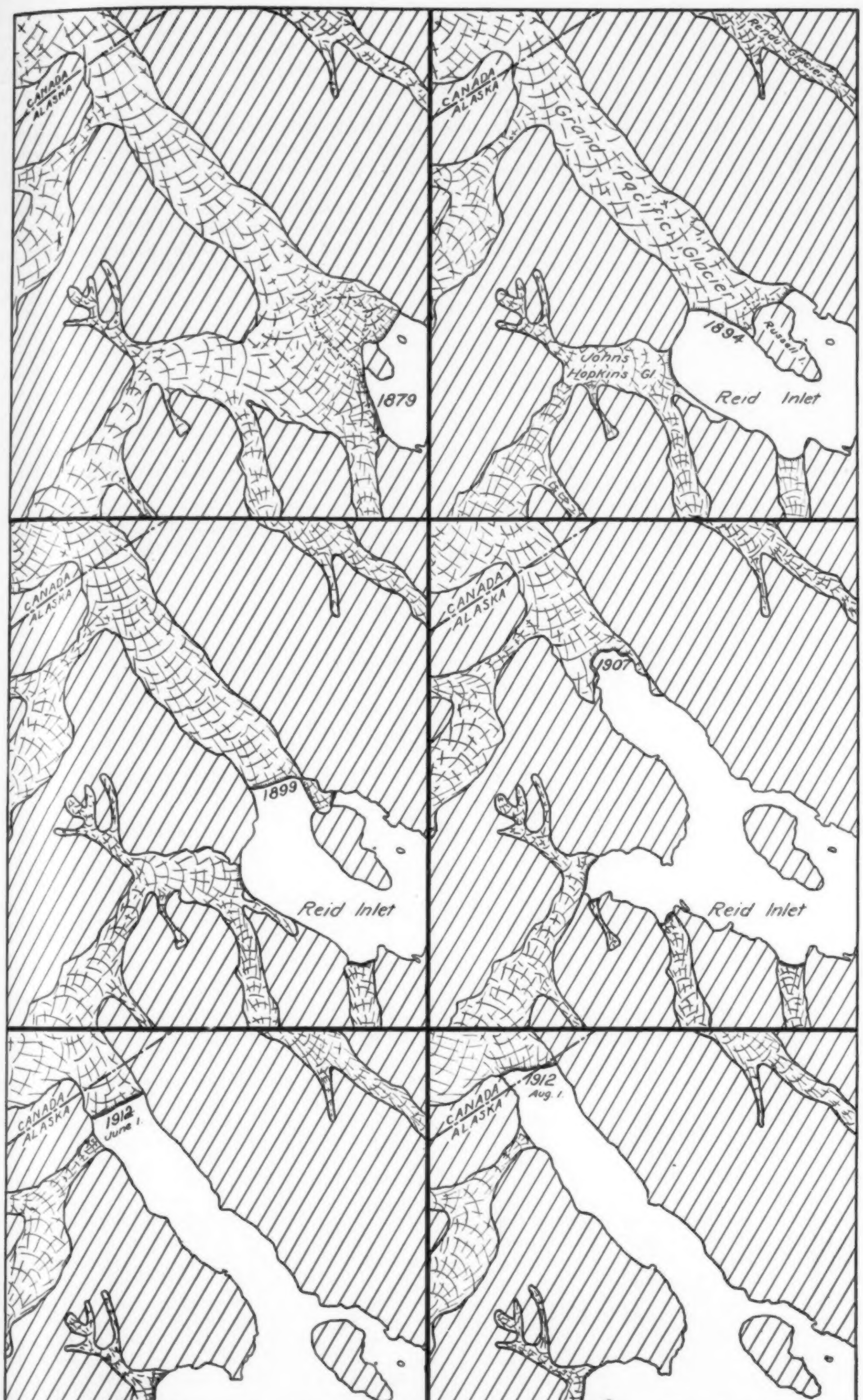
Ten miles east of Grand Pacific Glacier is the Rendu Glacier, whose terminus is in Alaska, eleven or twelve miles south of the international boundary. This tidal glacier receded 2,000 feet between Reid's visit in 1892 and that of F. E. and C. W. Wright in 1906. In 1907 it had commenced to advance, as is shown in photographs taken by the boundary surveyors in that year. Tarr and Martin visited this region in 1911 and found that the forward movement of the terminus of Rendu Glacier had amounted to at least 8,350 feet, or 1 3/5 miles, as far from Madison Square in New York city to Central Park. An adjacent cascading glacier had moved forward a quarter mile, becoming tidal. Similar recent advances in other parts of Alaska have amounted to a mile in 10 months in one case and 2 miles in less than 3 years in another. This should make it clear that Canada's new harbor in Glacier Bay is not altogether free from danger of future obliteration.

### THE ANCIENT RETREAT OF MUIR GLACIER.

The well-known Muir Glacier has had similar reces-

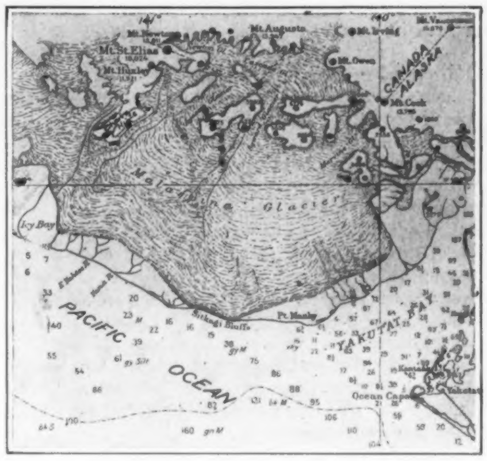
**Two-mile advances of Hidden Glacier between 1906 and 1909.**

Two photographs from exactly the same point. This is the greatest glacial advance that we know anything about from historical observations; that is, a forward movement of so great an amount in such a short time.



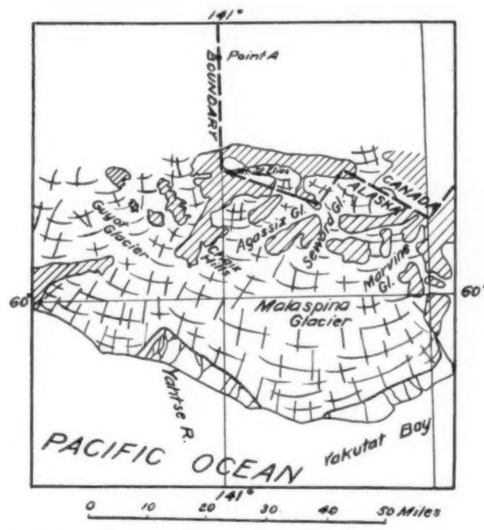

**Grand Pacific Glacier and the International Boundary.**

Large map of Grand Pacific Glacier and the extension of Reid Inlet to and past the International Boundary, between 1879 and 1912.



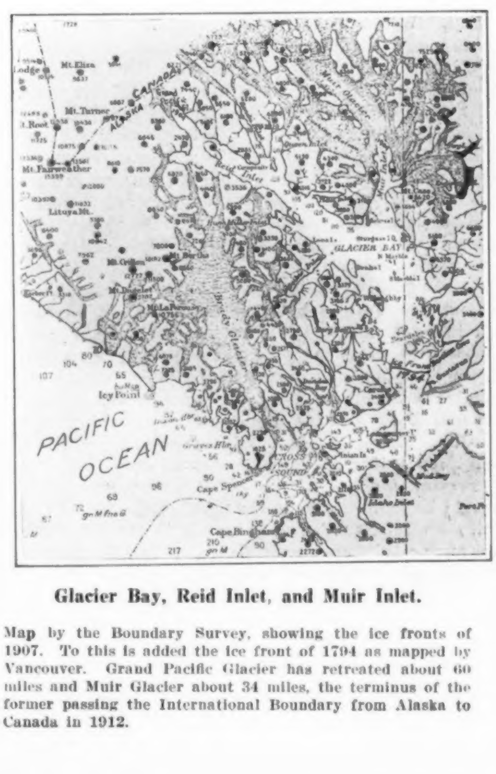

**The New Icy Bay and Malaspina Glacier.**

Map by United States Coast and Geodetic Survey, showing the New Icy Bay, formed in 1909 or 1910 on the site of the Icy Cape, which was the tidal terminus of Guyot lobe of the Malaspina Glacier. The New Icy Bay is a little farther west than the Icy Bay of Vancouver. Mount Saint Elias and the International Boundary are now only 26 miles from the waters of the Pacific Ocean.




**Malaspina Glacier and the International Boundary.**

Map showing condition from 1886 to 1909. The International Boundary is 10 marine leagues, or 35 miles from the sea, and turns northward on the 141st meridian near Mount Saint Elias. When this region was visited by Vancouver in 1794 the ocean was 20 miles inland from the present coast, reaching the base of the Chaix Hills. If the boundary had been then determined the turning point would have been near Point A, and several hundred square miles in Canada northeast of Mount Saint Elias would now have been part of Alaska.




**Glacier Bay, Reid Inlet, and Muir Inlet.**

Map by the Boundary Survey, showing the ice fronts of 1907. To this is added the ice front of 1794 as mapped by Vancouver. Grand Pacific Glacier has retreated about 60 miles and Muir Glacier about 34 miles, the terminus of the former passing the International Boundary from Alaska to Canada in 1912.

sions and advances. In the summer of 1911 we traveled in a boat on the fiord to a point 8 or 9 miles north of the ice front of the years between 1890 and 1899, when so many tourists visited Muir Glacier. We walked on dry land at a place where it is known that the rapidly-flowing glacier ice was 1,200 feet thick no longer ago than 1890. There we found logs of wood and, nearby, the upright stumps of trees. At this point a forest had grown with trees, set closely together and trunks a foot to eighteen inches in diameter, indicating more than a century of uninterrupted growth.

When was this time of extensive forest growth? Not before the first invasion of the region by glaciers, for the rock ledges below the tree roots are rounded and scratched or striated by glacier-borne bowlders. This period of forest growth was between the last great advance and an ancient recession. During this ancient recession the glaciers shrank to even smaller dimensions than the Muir Glacier of to-day. This ebb tide of glaciation lasted for a century or more, as the number of annual rings in the exhumed logs and stumps tell us.

The head of Muir Inlet near this buried forest is about 22 miles from the International Boundary. Suppose we insist that Canada's frontier shall keep back 35 miles from this point, which represents tidewater in 1911? Shall we be satisfied if the glacier advances and Canada asks us to again move the boundary? Of course not, for then the United States would be losing

territory. Just such an advance did take place, however, not so very long ago.

THE ADVANCE OF MUIR GLACIER.

No one knows the date of the latest great advance of Muir Glacier. It came after these trees had grown to maturity. It carried the ice front at least 34 miles to the south, and perhaps much more; that is from one point north of the site of the exhumed forest to the ice front mapped by Vancouver in 1794.

Thus we see that Glacier Bay has had, first, a great original advance of the ice tongues, which filled it completely, in common with all the fiords of southeastern Alaska; second, a recession to a stage when the glaciers were smaller than at present, this being perhaps one of many such recessions; third, an advance of more than 34 miles, most of which took place before 1794, though forward movement was still in progress about 1814; and fourth, a great recession between the latter date and 1911-12. One does not hesitate to predict future great advances and retreats, although the time of such oscillations cannot be foreseen. It is to be hoped that Muir Glacier will soon advance again, at least to the position of the ice cliff of the nineties in the last century, for then the glacier was far more beautiful to travelers than now, though the recent retreat adds an element of great interest to the scientist.

Clearly the international boundary should not be shifted with every such fluctuation of a glacier, nor should coastal boundaries in glaciated mountains be located without knowledge of and regard for such glacial oscillations.

THE MOUNT ST. ELIAS REGION.

Two hundred miles northwest of Muir Glacier is Mount St. Elias, 18,000 feet high, at whose base are the Malaspina Glacier and Yakutat Bay. Here the international boundry turns northward along the 141st meridian, and here also there have rather recently been great advances and recessions of the glaciers.

The boundary turns on Mount St. Elias, which is 35 miles from the present-day coast of the Pacific Ocean. Between the mountain and the sea are foothills and a flat expanse of ice, fed by coalescing ice tongues from the snowfields and cirques of the mountain. This ice mass at the base of the mountain, known as a piedmont glacier, bears the name of Don Alessandro Malaspina, an Italian in the service of Spain, who visited the region in 1792.

THE OLD ICY BAY AND ITS DISAPPEARANCE.

Capt. George Vancouver, in 1794, put into an indentation which he called Icy Bay and which subsequently disappeared. This English explorer charted the old Icy Bay and made soundings there, and a member of his crew made a sketch of the landscape. Vancouver's map of the old Icy Bay shows trees on the western side where there is now a barren glacier surface. The sketch shows that in 1794 the waters of the Pacific bathed the low foothills of Mount St. Elias, which we may recognize with little hesitation as the Chaix Hills. But the Chaix Hills are now separated from the sea by a score of miles of glacier ice, the western portion of the Malaspina Glacier. The glacier has advanced about 20 miles. Exactly when this advance took place is uncertain. It was after 1794. Possibly it was after the visit of Capt. Belcher in 1837, and certainly was some time before the visit of Dall of the Coast Survey in 1874 and 1880, and the mountain-climbing ventures of Lieut. Schwatka in 1886 and Prof. Russell in 1890.

The natives have preserved the following story of this glacial advance. The second chief of the Yakutat tribe stated to H. W. Topham in 1888 that his people used to have a village near the base of Mount St. Elias, where there was a large bay with sand and trees on the western side, that is, where the Guyot lobe of Malaspina Glacier is now. The glacier advanced and destroyed this village, making it necessary for the natives to settle elsewhere.

Alaska would have included two or three hundred square miles of what is now Yukon Territory in Canada if the international boundary had been fixed a century or so ago, before this gigantic glacial advance and with the coast line 20 miles inland from the present position.

THE NEW ICY BAY.

Within four years the western part of Malaspina Glacier has again retreated, forming a new Icy Bay, a little farther west than the Icy Bay of Vancouver. Capt. Quillian of the Coast Survey visited the place in 1911 and found that the Guyot lobe of the Malaspina Glacier had receded from 3 to 9 miles. Mount St. Elias, on the international boundary, is now only 26 miles from the waters of the Pacific, though when the boundary was located it was the full 35 miles or 10 marine leagues from the ocean. The seacoast is again moving inland toward the position it held when it was mapped by Vancouver in 1794.

RETREAT OF GLACIERS IN RUSSELL FIORD.

In the branch of Yakutat Bay called Russell Fiord, just east of Mount St. Elias, are the Nunatak and Hidden Glaciers. About a century ago these ice tongues were 20 miles nearer the seacoast than at present. This is known from the youthful vegetation of the 20 miles of fiord wall in front if these glaciers; and the date of the more advanced position is fixed approximately by the map of the Russian, Lieut. Khrontchenko, which was made in 1823.

If the international boundary had been fixed a century ago Canada would have made up for its loss of territory near Mount St. Elias by the addition to British Columbia of a part of what is now Alaska, in the region east and north of Russell Fiord.

Even this give-and-take as a result of differences in the coast line, in connection with the advance and recession of glaciers, would have been unfair, for neither the emaciated glacier coast, favorable to the United States, nor the advanced glacier coast, favorable to Canada, marks a permanent condition. See what has just happened. Hidden Glacier continued the recession of the nineteenth century during the period of recent observations from 1890 to 1906. But between 1906 and 1909 this ice tongue advanced 2 miles, probably in 1907.

All of these observations show the unfitness of the temporary terminus of a tidal glacier to be considered the head of a bay, especially in cases where the coastline bears an important relationship to the determination of an international boundary. The events of the last century in the vicinity of Mount St. Elias, Russell Fiord, and Glacier Bay have demonstrated this clearly.

# Some Aspects of the Subject of Transportation*

## I—Traffic by Land

By Lieut-Col. J. E. Kuhn

In the two decades between 1890 and 1910, the population of the continental United States grew from 63,000,000 to 93,000,000. During the same period the ton mileage of our railroads increased from 65,000 millions to 255,000 millions. Stated otherwise, while the population was increasing 50 per cent, the railroad ton mileage was increasing 400 per cent. To satisfy the demands of traffic in 1890, the railroads of the United States moved the equivalent of one ton of freight a distance of 1,032 miles for each individual. To satisfy the same demands in 1910 it was necessary to move the equivalent of one ton 2,742 miles.

Measured by any yard-stick we choose to apply, we are confronted with the same result, to wit, that traffic and production are increasing much more rapidly than population. Between 1890 and 1912 the production of pig iron, a recognized barometer of business, grew from 8½ million tons annually to nearly 30 million tons, an increase of 350 per cent. In the same period the coal production grew from 140 million tons to 550 million tons, an increase of 400 per cent. The manufacture of Portland cement had scarcely commenced in 1890, and amounted to only 1¼ million barrels in 1895. Last year the production was over 75 million barrels. Between 1889 and 1912, the freight tonnage on the "Soo" Canal grew from 7,400,000 tons to 71 million tons, an increase of 960 per cent in twenty-three years.

The graphical method is frequently resorted to in engineering questions, for the purpose of determining probable future developments. If we were to plot the curve of population for several decades past, we would obtain a fairly straight line showing an annual increase of about 1.5 per cent. The curves of production and traffic for the same period would be found to lie above the curve of population, with a strong tendency to escape at the top of the diagram. We may well pause to inquire whither we are going, and how long will the curves of traffic and production continue to rise at their present extraordinary rates. These questions not only present grave problems to the engineering profession, but are also intimately concerned with the present and future social and industrial status of the population.

In seeking for a reason for the greatly increased traffic demands of recent years, we are confronted with the difficulty of distinguishing between cause and effect. Unquestionably, traffic depends upon production and this in turn upon consumption, and we must, therefore, conclude that the increased traffic is the result of greatly increased consumption. But it may be said with equal truth that consumption is limited by production and traffic. In point of fact, all are inter-dependent and must keep pace with one another. The universal application of machinery to the arts and industries has greatly increased human efficiency and multiplied production and consumption manifold, placing within reach of the humblest and poorest comforts and conveniences undreamed of a century ago. New wants are being constantly created, and the luxuries of yesterday become the necessities of to-morrow.

It is related of Diogenes that he lived in a tub, with no other articles of furniture than a lantern and cup. Could we all live as simply as Diogenes there would be no transportation problems. But who wants to be Diogenes? Man these days requires and demands considerably more than the irreducible minimum necessary to provide food, shelter and clothing, and there are no present indications of any disposition to diminish these demands. We may, therefore, confidently expect that consumption, production and traffic will continue to increase in the immediate future, and perhaps for an indefinite time. Whether this condition of affairs is best for the human race is a sociological rather than an engineering question. Its effect on society is, however, plainly apparent in the steady change from an agricultural to an industrial community, in the increase of the urban at the expense of the rural larger cities, with its attendant complex problems of water supply, sewage disposal, intra-mural transportation and sanitation.

In 1890 the rural and urban population stood at 63.9 per cent and 36.1 per cent, respectively; in 1910 these figures were 53.7 per cent and 46.3 per cent, and in fourteen States the urban exceeded the rural population. These statistics are based upon an arbitrary classification, towns of 2,500 or less being treated as rural communities. Economic conditions, on which cheap transportation is undoubtedly a large factor, are responsible for the phenomenal growth of cities which have brought us the 55-story building with sub-sub-cellars, networks of street car lines above, on and below the street surface, and stupendous municipal improvements calling for fabulous expenditures. While there is every reason to believe that traffic, production and consumption will continue to increase, there are not wanting signs that there are practicable limits to the growth of cities. Land values and taxation in the large cities are becoming increasingly heavy burdens on industries and transportation, and sooner or later must operate automatically to check growth.

Reduced to its simplest elements the problem of transportation is concerned with the transfer of material from one locality to another. Under the influence of gravity such transfer invariably involves the overcoming of resistance, hence calls for the expenditure of energy and the performance of work. Increased efficiency in transportation methods can be secured only by a reduction of resistance or by a cheapening of the cost of the energy employed, and the successive stages of development are due solely to these causes. The primitive men who first discovered and applied rolling friction, or who utilized the buoyancy of water, marked epochs in the history of transportation no less than they who first applied steam and electricity as prime movers. In fact, it may well be questioned whether any event in the development of transportation equals in importance the invention of the wheel, which forms the fundamental basis of all our land transportation. Since the adoption of the wheel all improvements in transportation have been the result of either improved motive power or of improved paths offering less resistance. Animal power has been largely replaced by mechanical power, and the metalled road surface by the steel rail. A freight locomotive moving at an average rate of 15 miles per hour will haul 2,000 tons of freight a distance of 150 miles in 10 hours, equivalent to 300,000 ton miles. A team of horses on the best of metalled roads cannot haul 2 tons more than 20 miles in the same time. To equal

* Reproduced from the *Proceedings* of the Engineers' Club of Philadelphia.

the work of the locomotive there would be required 7,500 teams, with an equal number of drivers. These figures speak for themselves, and obviously make a comparison of operating costs superflous.

In the steam or electrically operated railroad there has been developed a means of land transportation which has enormously expanded traffic, revolutionized industries, and exercised a profound influence upon the social status of mankind. It should, however, not be overlooked that the conditions created by the railroads, like the railroads themselves, are largely artificial. We are accustomed to the belief that the very large modern city is a product of improved methods of transportation, and this is true in a measure, but there are to-day in China a number of cities with over a million inhabitants, which have managed to get along without the railroad. At the height of her glory, Rome counted 1,400,000 inhabitants, with no other means of transportation than the packhorse, cart and galley. But neither ancient Rome nor the Chinese cities enjoyed such comforts and conveniences as automobiles, electric lights, furnace heated houses, penny papers, moving picture shows, or the thousand and one other things which make up what we are pleased to call modern civilization. Improved transportation has simply stimulated production and consumption, and with them has produced the conditions which now obtain. The sudden elimination of the railroads from our civilization and a return to the old order would indeed be a calamity. Many persons who have acquired fixed habits would undoubtedly succumb to the shock, but the human race would not suffer extinction. Transportation in some form or other has always been a necessary factor in human welfare, and even in the days of the cart and packhorse amounted to a considerable quantity in the aggregate. What chiefly differentiates modern from ancient methods of transportation is its enormous volume, long haul and concentration.

THE RAILROADS.

The United States is preeminently a country of the railroad, and unquestionably owes its phenomenally rapid development to this agency of transportation. Of the 650,000 miles of railway line in the world, the United States possesses 244,000, or more than one third, and is easily first in the ratio of mileage to population, if not in the ratio of mileage to area, in which she is surpassed by the smaller but more densely populated countries of Europe. In 1910 the railroads of the United States were equipped with 59,000 locomotives, 2,300,000 cars, and employed 1,700,000 people in their service. Their outstanding capital was 18,000 millions of dollars, and their gross revenues 2,750 millions of dollars, which amounts to an average annual payment of $30 for each inhabitant for railway transportation. Successive economies in operation and administration, as well as increased volume of traffic, have reduced transportation charges to an astonishingly low figure, which has been maintained for a long period notwithstanding increasing wages, higher priced materials and increased taxes. The average freight rate of 20.9 mills per ton mile which obtained in 1865, fell steadily until in 1888 it reached the figure of 7.7 mills per ton mile, a reduction of nearly two thirds in twenty-three years. Since 1888 the average ton mile freight has remained practically stationary, being given as 7.48 mills for 1911 in Poor's Manual.

The fact that railway management has been able to maintain freight rates in the face of the marked rise in prices of labor and material, and still pay dividends, is no mean tribute to the wisdom, energy and ability of the officials.

Since 1890, most of the trunk line railroads have practically reconstructed their systems. Heavy expenditures, both of capital and of surplus earnings, have been invested in reducing curvature and grades, rebuilding bridges, supplying heavier equipments and in improving terminal facilities, all of which have conduced to economies in operating expenses and have enabled the railroads to maintain the present low rates. The question of greatest concern to the public at the present moment is whether we may look for a still further reduction of freight rates. On the basis of the traffic reported for 1910, a reduction of 1 mill in the average ton mile freight rate would effect a saving of $255,000,000 annually to the public. In view of the world-wide rise in prices, it seems hardly possible that there will be any material reduction in the cost of railway transportation. In fact, the immediate future threatens an increase of freight rates, as evidenced by a number of applications to the Inter-State Commerce Commission with this object in view.

That further economies in railroad transportation are still practicable cannot be questioned. While we appear to have about reached the economical limit of reduction in train resistance, with our present system of track and rolling stock, there are still possibilities of considerable economies in the matter of train operation and terminal expenses. In 1880 the average freight train load was only 129 tons. In 1910 this had increased to about 350 tons. Considering the power of the modern locomotive to haul heavy loads, there is still room for considerable improvement in train loads with resultant economy. Further improvement in car capacity in comparison with car weights may also be looked for. At present freight cars have a rated capacity of from 2 to 2½ times their weight, which means that even with fully loaded cars about one third of the train load is tare weight, bringing no revenue. The Norfolk and Western Railway has recently put into service a coal car of 200,000 pounds capacity, weighing 62,500 pounds, giving a ratio of 3.2 of capacity to weight. As indicating the possibilities of train loads, it may be mentioned that about a year ago a single Mallet locomotive hauled a total load of 9,120 tons on the Virginian Railway, of which 6,600 tons was paying freight. The train consisted of 120 loaded coal cars containing 55 tons each, and the haul of 120 miles was made at an average running speed of 15 miles per hour.

In general the larger the container, the greater the proportion of the net weight of contents. Unfortunately, limitation of clearances and stability with the present gauge have placed a limit upon the height and width of cars, and the increase of but one linear dimension will not have any very marked effect in improving the ratio between net and tare weights of freight car loads. In this connection it is open to argument whether a broader guage than standard, permitting the use of larger cars and heavier loads, with shorter trains, would not afford more economical transportation. Were it a matter only of long haul through traffic, there could be no question as to the superiority of a broader gauge, but considering transportation as a whole, the unsuitability of unduly large equipment for feeder lines and the advantage of an interchange of cars, the present standard gauge is perhaps not far wrong.

In the matter of efficiency of freight car equipment, much remains to be desired. In 1890, statistics of 1,000,000 freight cars in service showed that the average daily distance moved was only from 17 to 25 miles, a two hours' run. In a recent article by the General Superintendent of Transportation of the Illinois Central Railroad, there appears to have been but little improvement in this particular, the average movement of all freight cars on that line being but 27 miles per day. The records showed that as an average for each month, 13 days were spent in loading and unloading, 3½ days in moving, and 13½ days standing. Even a slight increase in the daily car mileage would result in large economies, both in first cost of equipment saved, and increased revenue from equipment in use. This is a question of operation and terminal facilities, which constitute the chief fields for the practice of further economies. In comparison with haulage charges the terminal freight charges in large cities are unduly high. Congested freight stations, antiquated methods of loading and unloading cars and high cost of land are laying a heavy embargo on transportation to and from the largest cities. To remedy these conditions will call for heavy expenditures, but unless terminal facilities keep growth with the ever increasing volume on tonnage the traffic capacity of the railroads will soon attain its limit, and this long before track capacity shall have been reached. Since 1890 railroad mileage has increased 50 per cent, while the ton mileage has increased 400 per cent, and the density of traffic is susceptible of still further increases, but only on condition that freight terminal facilities and the efficiency of freight equipment be increased correspondingly.

Whether we may ever expect any radical change in track construction is problematical. Systems of construction like the mono-rail, overhead and gyroscopic, or the sliding railway exhibited at Paris in 1889, afford promising possibilities in the way of reducing tractive resistances, but the cost of their installation has so far prevented any economical results. The question of a change of motive power, from steam to electricity is an open one. For city terminals electricity has certain advantages which have led to several notable installations, and there are indications of its extension to main line traffic where hydro-electric plants offer attractive rates for power. For the time being the question of electricity or steam is more a question of convenience than of economy, and we may expect the steam locomotive to hold its own for some time in the future. To sum up railroad transportation, further improvements in haulage costs will probably not be material, but in the matter of operation and of terminal charges there is still room for important economies.

MOTOR VEHICLES.

About fifteen years ago the automobile made its first appearance upon the streets of our cities as a practicable pleasure vehicle. To-day over one million machines are hurrying and scurrying through the highways and byways of our vast land. As a pleasure vehicle, the automobile has practically displaced the horse-drawn carriage, not because it is a cheaper form of transportation, but because one can go farther and faster and have more fun. While the large number of pleasure cars has not been without some effect on passenger transportation, especially intra-mural and suburban, this has been small in comparison with the volume of the business, and merits no further consideration.

Within a very few years, however, the self-propelled vehicle has been applied to uses other than pleasure, and promises to become a real factor in the transportation problem. I refer to the rapidly increasing adaptation of the motor truck to commercial uses, which greets one on all sides in and about our larger cities. The mere fact that progressive merchants, manufacturers and contractors, to whom the question of dollars and cents is of paramount importance, are committing themselves to motor trucks for delivery and haulage purposes is sufficient evidence of the economical advantages over horse-drawn vehicles.

Motor trucks are now manufactured with capacities up to 10 tons, and by suitable modifications of their bodies are adapted to a wide range of special services. Greater loads and greater speeds have established conclusively the economy of the motor as compared with the team for all classes of city and suburban delivery where good roads are available. Under favorable conditions a heavy truck will negotiate 300 to 400 ton miles per day, as much as 7 to 10 teams of horses. A prominent maker of motor trucks claims a cost of 4½ cents per ton mile as compared with 11 cents for teaming.

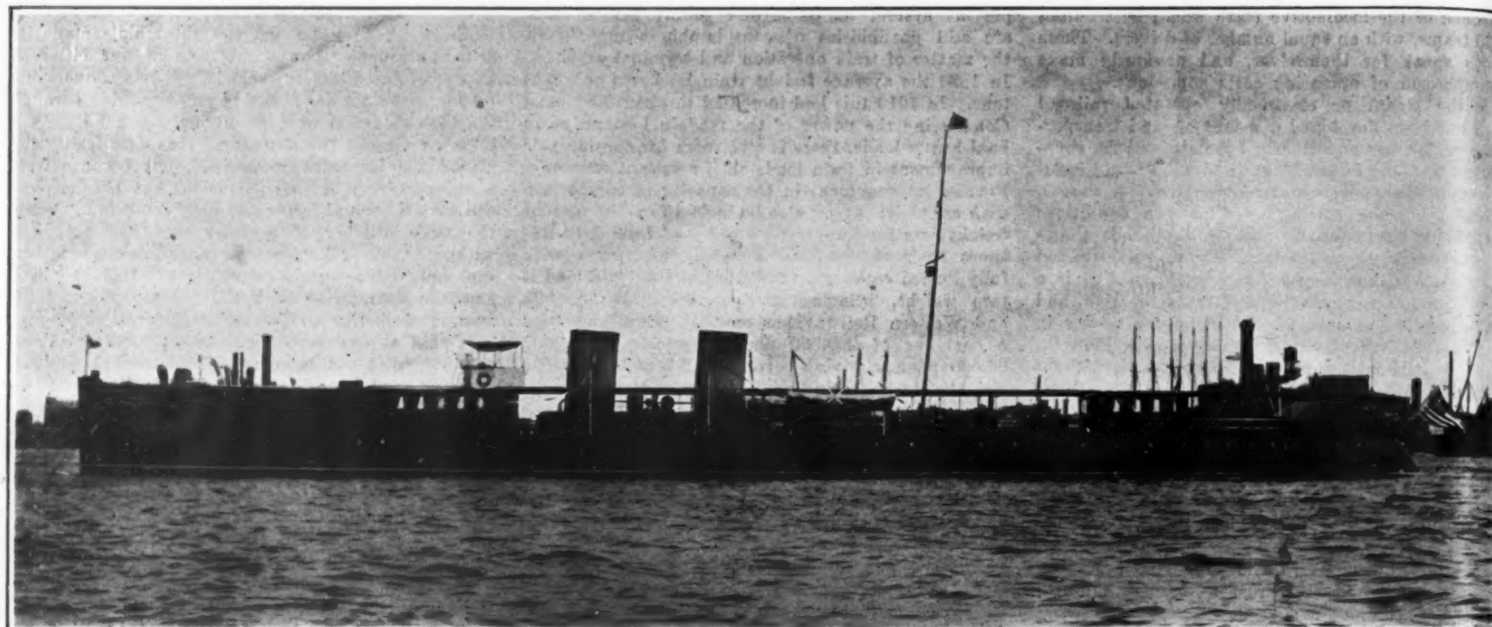
Although motor truck transportation is still in its infancy, it has already assumed formidable proportions. Many manufacturers of pleasure cars have added commercial cars as a branch of their business, while other concerns limit their output entirely to this class, and all are prospering. Aside from its already established advantages as a means for delivery and haulage within cities and their immediate suburbs, there are other possibilities for the motor truck, some of which have a direct bearing on the general problem of transportation. A motor truck can be handled with much more certainty in cramped quarters than can horse-drawn trucks. This will enable them to run directly into shipping and packing rooms to receive or discharge their loads, without the necessity of trucking. By proper arrangements at freight receiving and delivery stations, motor trucks can be run directly alongside freight cars, and trucking saved at this point likewise. The reduction of trucking charges will go a long ways toward reducing terminal charges which form so large an element in transportation costs.

Another use for the motor truck is in the direct haulage of freight over considerable distances, cutting out intermediate railway haulage. Such direct deliveries will save rehandling and often packing, and where the distance is not so great but what the truck can return to point of origin the same day, may afford as economical a service as the railway, as well as a speedier one.

A necessary adjunct of motor vehicles in their present state of efficiency is good roads. Without good roads the motor vehicle loses all its advantages over the horse-drawn vehicle. In comparing transportation cost by motor truck with other forms, the cost of constructing and maintaining good roads should be charged, in part at least, to the motor truck. Since the advent of the automobile there has been a widespread popular movement for improved highways, and vast sums have already been expended on this account, while still larger expenditures are in contemplation. In both first cost and in maintenance the character of highway demanded for motor vehicles is much more expensive than appropriate for wagon traffic. High-speed passenger and heavy commercial cars are very destructive to ordinary road surfaces and the increased cost both of construction and maintenance should be charged against this new form of traffic, instead of being borne by the general community.

Until there is a vastly great mileage of improved highways, we may expect the field of the motor truck to be limited to the larger cities and their immediate suburbs. In Europe with its network of excellent highways and dense population there is a better field for the motor truck outside of city limits, and this form of transportation has consequently made greater progress than in the United States.

(*To be continued.*)



# The Steam Yacht "Winchester"

# A Thirty-Two-Knot Craft

AMONG the recent additions to the fleet of the New York Yacht Club the vessel which has undoubtedly attracted the most attention, and deservedly so, is the new turbine steam yacht "Winchester," which was designed by Messrs. Cox & Stevens for Mr. Peter Winchester Rouse, this vessel having been built by Messrs. Yarrow & Co., of Scottstown. The vessel was delivered to her owner after a trip across the Atlantic, during which time she encountered a succession of heavy northwesterly gales and proved herself a superb sea boat, arriving in port without the slightest sign of damage.

The "Winchester" is 205 feet in length, with a beam of 18 feet 6 inches, the hull being of steel and in type very similar to the recent torpedo-boat destroyers, having a high raised forecastle associated with extreme flare of the forward sections, thus producing the best possible sea-going hull particularly for a high speed proposition. The vessel is flush-decked throughout and has on deck forward a large dining room, the top of which is at the same level as the forecastle deck, a most unusual feature and a very practical one, as in other high speed vessels the deck house windows are liable to be shattered when driving into a head sea. There are two large funnels, one military mast and a large after deck house containing the companion stairs to the owner's quarters, which are below aft, and consist of a large saloon and the owner's room, extending the full width of the vessel, a large bath room with dressing room attached, also two comfortable single staterooms and one large double stateroom with two baths.

The "Winchester" is painted black, and with her long, easy lines, straight sheer, and other features already described, she presents a most unusual and attractive appearance, every line indicating speed and serviceability, which is what the owner desired to attain.

The "Winchester's" machinery installation consists of Parsons turbines, driving twin screws, the total shaft horse-power being approximately 6,000, steam being supplied by two oil-fired water-tube boilers of the Yarrow type, these being ample size to produce sufficient steam to run the engines at full power for an indefinite period.

Although the contract speed for the "Winchester," viz., 32 knots, was considered unusually high, being the maximum ever required in a building contract for a yacht of any type, it is interesting to note that this speed is attained with the utmost ease; in fact, with 165 pounds of steam pressure it can be easily held, and as the boiler pressure allowed is 260 pounds, it will be seen that the contract speed is but a small matter compared with the speed at which it is possible to drive this vessel.

Although the owner was not desirous of driving the "Winchester" at maximum speed this summer, and therefore no definite speed trials were run, it is safe to say from observations taken, that with the full speed pressure of steam it is no task at all for her to make 34 knots or better than 38½ statute miles an hour. While these figures as regards speed are, in themselves, remarkable, the most remarkable feature of all is that even while the yacht is running at this extraordinarily high speed, there is an absolute absence of vibration on the boat, and she moves through the water without creating any appreciable

The turbine engine room.

The long flush main deck.

disturbance whatever so far as can be seen from the boat itself, the wake being perfectly flat, the diverging wave system being scarcely noticeable; and in fact the only sign of high speed when on board except the swift passage of the water by the boat, is the thin and high bow wave which is turned down by the flaring sides in such a manner as even in a cross wind with a choppy sea to prevent water and even spray coming on deck.

The entire crew consists of fourteen men, whereas the average engine room force alone in an ordinary steam yacht of her length, having a speed in the neighborhood of twenty-one or twenty-two knots, with about the same accommodation, using reciprocating engines and coal-fired boilers, is greater than the total crew of the "Winchester." While naturally in utilizing her full power, she consumes a large amount of fuel per hour, she can cruise with economy at unusually high speeds. During a recent trip from Halifax to New York she averaged better than 18 knots per hour with no fire under one boiler at all and only one half of the burners under the other boiler in operation, thus utilizing practically one quarter of her total boiler power. Under these conditions her fuel consumption per mile is extraordinarily low, even as compared to the most economical reciprocating engine coal-fired boiler installation.

# Blood Parasites*

## Elusive Foes of Mankind

By H. G. Plimmer, F.R.S.

You will remember that Mephistopheles, when he insists upon the bond with Faust being signed with blood, says, "*Blut ist ein ganz besondrer Saft*" ("Blood is a quite special kind of juice"). Goethe would probably not have used the word "*Saft*" had he been writing "Faust" to-day instead of in 1808, for at that time the cellular elements of the blood, although they had been seen and described by Leeuwenhoek in 1686, were believed to be optical illusions, even by so distinguished a person as the professor of medicine of that time at the Sorbonne. The incredulity of scientific men as to what they see is proverbial and astounding, fortunately; but it is probably because science is really quite sure of nothing that it is always advancing.

I shall try to show you the barest outlines of our present knowledge of the parasitology of the blood. It is a subject of great practical and economic importance, as many grave diseases of man and beast are caused by these parasites, which, on account of their minuteness, enormous numbers, and very complex life-histories, are very difficult to eradicate or to deal with practically. On this account there is a good deal of the enthusiasm of the market-place mixed up with this subject, which, although a new one, has advanced with great rapidity, and has revolutionized pathology, and medicine so far as possible. From our point of view it began in 1880 with the discovery by Laveran, in the military hospital of Constantine, of the parasite which causes malaria. This caused the protozoa, to which order most of these parasites belong, to oust bacteria from the proud position they then occupied of being the cause of all the ills we have to bear, and to reign in their stead; not an altogether desirable change; for when you have seen what I shall show you, you will agree with me that sufficient unto life is the evil thereof. It has had all the disadvantages of a new subject, and since that time floods of work have been poured into journals, annals, proceedings, etc., some of it of the best, with much of it that is indifferent, temporary, and bad; so that at times it seems as if this branch of science were in danger of being smothered in the dust of its own workshop, or drowned in the waters of its own activity. We do not, nowadays, keep our ideas and scraps of work to ourselves until they are either established, or, as is more likely, dissipated, so we have a huge mass of what is called "literature," filled with many trivial, fragmentary, and doubtful generalizations, many of which we have with pain and trouble to sweep into the dust-bin; nature's blessed mortmain law taking too long to act. You remember Carlyle complained, to use a mild term, of Poggendorff's *Annalen*, and I feel sure that, if he had had to study blood-parasites now, he would have said that it was a much over-be-Poggendorffed subject. Blood-parasites are afflicted, too, with terrible names, and with large numbers of them; some have as many as ten or even fifteen different names, perhaps on the Socratic principle, that naming saves so much thinking. And they are in Latin, too, so that the terminology of this subject is a perfect museum of long Latin and hybrid-Latin names. The terminology generally of our later biology is, as one has said, "the Scylla's cave which men of science are preparing for themselves, to be able to pounce out upon us from it, and into which we cannot enter." This will be my excuse if I should use words you do not understand.

I will just remind you of the structure of the blood, that it consists of an extraordinarily complex fluid, the plasma, which holds in suspension living cellular bodies, called cells or corpuscles. These are of two kinds, red and white corpuscles. The red are by far the more numerous, and in man there are about 5,000,000 of them to a cubic millimeter of blood, but this number varies enormously under the influence of parasites. To these red corpuscles is due the red color of the blood, and they are the carriers of oxygen, acquired by the aeration of the blood in the lungs, to the tissues. We breathe in order that they may breathe, for we only care about oxygen in so far as they care about it.

The other kind of corpuscles are the white, or leucocytes, and of these in health there are about 7,500 per cubic millimeter. A few years ago it was enough to know that there were red and white corpuscles, but now we have to know more. Through the work of Ehrlich we know that there are at least five different kinds of leucocytes in normal blood, which I will just indicate to you.

1. *Lymphocytes.*—These are the smallest cells, and contain a relatively very large nucleus.
2. *Large Mononuclears.*—These are large, and are called macrophages, as they possess the power of being able to absorb and digest parasites and other foreign bodies.
3. *Polynuclears.*—These are characterized by the irregular, moniliform aspect of their nucleus, and they are called microphages for the same reason that the large mononuclears are called macrophages. Both of these are also called generally, phagocytes, on account of their power of ingesting and digesting foreign bodies.
4. *Eosinophiles.*—These are characterized by a bilobed nucleus, and by granulations which color deeply with eosin and other acid colors.
5. *Labrocytes or Mastzellen.*—These are rare, and are characterized by large granulations which stain with basic colors.

In parasitic diseases these corpuscles are profoundly modified and altered, numerically and morphologically, and other new elements may make their appearance in the blood.

The blood is essentially the same in all animals, but it varies within certain limits. For instance, the red corpuscles are not of the same size and shape in every animal, and in birds and fishes they are nucleated; in us they are only nucleated in fœtal life and in disease. The mononuclear and polynuclear leucocytes are really separate organisms living in us, and they have qualities which it is very difficult to call anything else but consciousness; so that it is a subtle distinction to draw the line between the parasites, which these leucocytes are, in a way, which are part of us and those that are not. When the balance of power is well preserved among our leucocytes, when they are working well together, then all is well with us; if we are ill, it is because they are quarreling with themselves or with an invader, and we send for Sir Almroth Wright to pacify or chastise them with his vaccines.

So that, as Darwin said: "An organic being is a microcosm, a little universe, formed of a host of self-propagating organisms, inconceivably minute and numerous as the stars in heaven," as we ourselves are but parts of life at large.

The three main functions of the blood are: That it is a means of respiration, a means of nutrition, and a defense against invading organisms.

And now to these latter. A blood-parasite proper is a living being, vegetable or animal, passing part or the whole of its existence in the blood of another living being, upon which it lives, this being obligatory and necessary to its life-cycle.

It was in 1841 that the first blood-parasite was seen by Valentin in the blood of a fish, and two years later Gruby gave the name trypanosoma to an organism he found in the blood of a frog. But since Laveran's discovery of the malarial parasite in 1880, we have learnt to differentiate many other parasites as causal agents of such diseases as I shall mention later in connection with the various parasites. But we know as yet dangerously little about most of them, so that we have strenuously to resist the temptation to make our account of them sound too harmonious, before we have found half the notes of the chord we are trying to play. We speak, as it were, with authorized uncertainty, and there are parts of our science which, after all, are only expressions for our ignorance of our own ignorance. These parasites have a very complicated life-history; part of their life-cycle is passed in the blood of man or beast, and part in various parts of the body of some blood-sucking invertebrate, such as a fly, mosquito, or tick, which transfers the parasite to another animal while feeding from him. It was thought formerly that blood-parasites would be a restricted order, but the work of recent years has shown that they have an enormous distribution both geographically and as regards their hosts. For instance, during the last five years I have had the opportunity of examining all the animals (in the large sense of the word) which have died in the Zoological Gardens. I have examined the blood of more than 8,000 animals, coming from all parts of the world, and I have found parasites in the blood of 587 of them, that is in about 7 per cent, and in 295 species of animals I have found them for the first time. I mention this just to give you some numerical idea of their occurrence and distribution.

It will be better to take first those parasites which live in the plasma, and then those that live in the corpuscles, rather than to attempt to take them in their, at present rather uncertain, biological order; and I will begin at the bottom, biologically speaking, that is with the bacteria which are plants. These only require mention, since they do not live in the blood as parasites proper, but only as accidental parasites, that is, parasitism is not necessary to their life-cycle; they get into the blood in the later, or in certain, stages of certain diseases.

An example is the blood of a Senegal turtle-dove which died in twenty-six hours from fowl cholera. This bacillus was discovered by Pasteur, and is interesting, as it was his work upon it which led to his discovery of the attentuation of a virus, and of its transformation thereby into a protective vaccine.

The first parasites proper I shall mention are the Spirochetes. These have at present rather an insecure position in our idea of nature; they were formerly classed close to the bacteria, but now they are placed tentatively among animals, and they are not yet quite sure of their place. But they, nevertheless, although insecure of their place in the books, produce grave diseases, such as relapsing fever, tick fever of man, the spirochetoses of horses, oxen, and birds, syphilis, and yaws. They, with the exception of the last two, are carried by, and developed in, ticks and bugs; and in tick fever the parasite is also found in the nymph form of the tick, and this is one of the rare instances of heredity of a parasite.

The spirochete of relapsing fever in man was discovered by Obermeier in 1868, and he died from inoculating himself with the blood of a patient with the disease. He was one of the first scientific martyrs; he established our knowledge of the cause of this disease at the expense of his own life.

We will now take a long jump to the Filariæ. These are nematode worms, the embryo forms of which live in the blood; the parent forms, being too large to get through the capillaries, live in many other parts of the body. The larval form lives in the body of some invertebrate, in a few known cases in a mosquito, or in a crustacean. The microfilariæ were discovered by Demarquay in 1863. Many of them show a remarkable periodicity, some appearing in the blood at an exact hour at night, and some in the day, for which phenomenon there is at present no satisfactory explanation.

Some are short, and some long, and some are incapsuled, others not. Filariæ cause various diseases, probably elephantiasis, and certainly enormous varicosities of the lymphatics, chyluria, chylous dropsy, Calabar swelling, and certain tumors.

We now come to the trypanosomes. They are flagellated organisms, which are the cause of many deadly diseases in men and animals, such as sleeping

* Abstract of a discourse delivered at the Royal Institution.

sickness, nagana (or tsetse-fly disease), surra, mal de caderas, dourine, and others. They are transferred from animal to animal by biting flies, fleas, lice, and leeches, in which the sexual part of their life-cycle takes place. The first one was seen in the blood of a frog by Gluge in 1842.

A type example is *T. lewisi* in the blood of a rat. This was discovered by Lewis in 1878, and is found in about 25 to 29 per cent of wild rats. Some die, but most recover and become immune; it is a very specific parasite, and cannot be transferred to any other kind of animal.

The *T. brucei*, causing nagana or tsetse-fly disease, probably exists in the wild game of South Africa, much as the *T. lewisi* does in the wild rats, but when it is carried by the tsetse-fly to domesticated animals it kills them one and all in enormous numbers.

The *T. gambiense*, which causes sleeping sickness, was first seen by Dutton in 1902, and is carried by another species of tsetse-fly.

Nature attempts to fight against these invaders by phagocytosis. The parasites, however, multiply so rapidly that this method of attack is not very effectual; it can only be so in very early infections, and probably it then often is, that is, before the parasite has had time to start dividing. At the present time the question of trypanosomosis among man and animals is, for many countries which have colonies, of the greatest economic importance, so that a great deal of work has been done in the attempt to find a cure. A great many drugs, new and old, have been tried, and some good has been done. The first drug which was found to be of service was arsenic, first in simple and then in complex combination, and the subcommittee of the Royal Society, formed for the purpose of supervising experiments in this direction, suggested the trial of antimony in these diseases, on account of its near chemical relationship to arsenic.

This has given better results than arsenic, and a commission is at present at work in Africa, in the Lado district, trying its effects on a large scale. We found that the salts of antimony were too rapidly eliminated from the body to be successful in the larger animals and man, and so we devised a very finely divided form of the metal itself which we put directly into the circulation, and this has given, so far, the best results. The leucocytes eat it up and transform it slowly into some soluble form, taking, in a horse, for instance, four days to dispose of one dose, and the effect of this is much more profound and lasting than that of the salts. But some trypanosomes always escape, since one dose is never sufficient for cure. In rats with nagana, in which the trypanosomes by the fifth and sixth day may number 3,000,000 per cubic millimeter of blood, the minimum number of doses for cure has been found to be four, and with this dosage it is possible to cure 100 per cent of rats.

It is interesting in this connection to remember what Bacon, whose death, you know, was due to an experiment he undertook to prove the preservative action of intense cold upon animal bodies, says: "Laying aside therefore all fantastic notions concerning them, I fully believe, that if something could be infused in very small portions into the whole substance of blood . . . . it would stop not only all putrefaction, but arefaction likewise, and be very effectual in prolonging life." His vision was prophetic!

The bird trypanosomes are very much larger than the mammalian variety, are very dense, and move much more slowly.

An example of an organism very closely allied to the trypanosomes which is found only in fishes' blood is the trypanoplasma. It has two flagella, and the micronucleus is very large. This organism is probably transferred by leeches, but very little is yet known of it.

There are other flagellated organisms which may appear in the blood and live there as accidental parasites. There is a kind of inflammation of the intestines in reptiles (in the large sense) which causes the mucosa of the intestine to become permeable, so that some of the organisms which live in the intestine are able to get into the blood and live there. The only mention of these organisms in the blood is by Danilewsky, who in 1889 found hexamitus in the blood of a frog and tortoise. When in the blood they appear to excite a general œdema and ascites. I have found them now in nine cases. These are interesting as showing the power of adaptation to new surroundings possessed by these parasites.

I now come to the intracellular parasites.

Schaudinn thought that the bird trypanosomes had an intracellular stage, and if this were so they would form a bridge between the extra-cellular parasites, of which I have quoted types, and the intracellular parasites we are about to consider. But Schaudinn seemed, with his very brilliant attainments, to want a little more ballast of medical earth-knowledge. His work on this point has not been confirmed, and he was probably misled by a double, or even treble infection, so that we must think of these intracellular parasites as quite distinct from the others.

I will take first the *Plasmodium praecox*, the cause of the malaria in birds, as this parasite is of great historical interest; for it was Ross's work on this organism and his discovery of the rest of its life-cycle in the mosquito, which enabled him, on account of the great likeness between this and the parasite causing human malaria, to deduce from the one the etiology of the other, which was confirmed by Grassi and others. The *Plasmodium praecox* is, in many stages, so like human malaria that it can only be differentiated by the presence of the oval nucleus of the bird's red corpuscles. The life-cycle is very complex, part taking place in the blood of the bird, and another part (sexual reproduction) in the body of a mosquito. This parasite was first seen by Grassi in 1890; it is very widely distributed, and is very deadly to birds.

Human malaria has been known for centuries. Varro, who knew a good deal about what we should now call hygiene, more than a century B. C., thought that malarial fevers were due to invisible animals, which entered the body with the air in breathing, and Vitruvius, Columellus, and Paladius were of the same opinion. Now we know that the mosquito is again the carrier, and that the sexual part of the parasite's cycle takes place in it, but whether the mosquito alone can account for all the phenomena of malaria is not yet quite certain.

There are three varieties of malaria in man, the tertian, quartan, and quotidian; in the tertian the cycle of the parasite in the body takes forty-eight hours, and in quartan seventy-two hours, and in pernicious malaria the fever is very irregular, but continuous. Whether there are three different parasites, or only one, which is altered according to its environment of host, climate, etc., is still apparently uncertain. Laveran and Metchnikoff believe in the specific unity of the parasite, whereas some observers want as many as five different species.

Just as in human malaria the pernicious form is distinguished by the elongated form of its gametes, so in birds there is a parasite which is distinguished, in the same way, from *Plasmodium praecox* by its very elongated gametes. This parasite is called *Haemoproteus danilewski*. Its development is unknown; it begins as a tiny, irregular body in the red corpuscles of the bird, then it grows in the long axis of the cell and turns round the end of the nucleus. It is possible in these parasites to follow the process of impregnation, which normally takes place in some insect. By taking the blood when full of the long, fully-grown gametocytes, and keeping it for a time outside the body, this process can be followed.

First of all, the gametocytes escape from the blood-corpuscles and roll themselves up into a ball. Some of these remain quiet, the females, curiously, the macrogametocytes, while in the microgametocytes active movements are seen; then tailed processes are seen projecting from its surface, which at last get free and wander about in the blood, this constituting the origin of the microgametes from the microgametocyte. They then find a macrogamete, and penetrate into it and fertilize it. This fertilized macrogamete then alters its shape and becomes an ookinete, with the remains attached containing the pigment. It may enter a red corpuscle, but it usually breaks up, because it finds it is not in the stomach of the insect it intended to be in, but between two pieces of glass.

From Hæmoproteus it is easy to pass to a rare and undetermined parasite of the blood of birds called a Leucocytozoon. It occurs in the blood in the form of a long, spindle-shaped unpigmented body. Very little is known of it except that it is found in its sexual forms. The earliest observers of this parasite (Danilewsky and Ziemann) believed the host-cell to be a leucocyte (hence the name), but Laveran has shown that it is a red corpuscle.

We now come to a group of parasites of great practical importance, the Babesias, formerly called Piroplasma, which are the cause of Texas fever or red-water fever, malignant jaundice, East Coast fever, and biliary fever among domestic animals. We know, again, little that is certain concerning this group, except that they are unpigmented parasites of the red corpuscles, and are carried by ticks. They are the most destructive to the blood of any we know. In an ox, I have seen the red corpuscles decrease from 8,000,000, the normal, to 56,000 per cubic millimeter in two days.

Another important group, the Leishmania, is still uncertain of its exact position. In the body they occur as small bodies with a nucleus and micronucleus, but when cultivated on artificial media they become flagellated organisms of herpetotomas type. It is not quite certain what insect plays the part of carrier, but the different varieties of this group cause the diseases known as Kala Azar or tropical splenomegaly, Oriental sore, Delhi boil, Biskra boil, etc., and also infantile splenic anæmia.

The last class are the Hæmogregarines. These are parasites of the red corpuscles of reptiles principally, but they have been described in mammals and birds. We only know certain stages of the greater part of them; they are large, sausage-shaped bodies, not pigmented, and they are supposed to be carried by leeches, ticks, lice, and fleas. They generally have a capsule. In some instances the host-cell is enormously enlarged and entirely dehæmoglobinized, but in most cases the host-cell is not enlarged.

I have now taken you over some examples of all the known types of blood-parasites, but, at best, the picture in your minds must be like that of a landscape taken from a railway carriage at full speed; and the result, I fear, only a kind of clarified confusion, but it will be something if I have succeeded in making it transparent at the edges. What must have struck you most is the smallness of our exact knowledge of many of these extraordinary organisms and the gaps that there are even in this. But the incitement to future work lies in this fact, for:

"Things won are done; joy's soul lies in the doing."

## German Silver

**By A. A. Somerville**

Frequently the trade name of an alloy is at least partly indicative of the elements entering into that alloy. But this is not so in the case of german silver. It is one of the biggest misnomers in the trade to-day. To begin, there is no reason why the name, or rather word, should be capitalized. It did not originate in Germany, and the greater portion now in use was not made there and the largest producers of the same are not located in Germany, notwithstanding the name at once suggests such ideas. And then again the biggest surprise is experienced when one learns that there is no silver in the concoction whatever.

Ask an honest retail jewelryman, "What is german silver?" He will reply in a tone of voice not the least extraordinary, "Oh, that's *German* Silver." And then he will go on to explain that their (the German's) silver is very much inferior to ours, that it is not like our silver and not near so valuable. He doesn't realize that silver is silver the world over, and always the same, even in Mars, or else it *isn't silver*. He would scoff at the idea suggested that german silver consisted of a mixture of copper, nickel and zinc and would have good reason for so doing unless he had received some instruction along the manufacturing end of his business.

Historically speaking, a white metal consisting of a mixture of copper and nickel together with various other metals having rather low melting points, was made and used by the Chinese centuries ago. It was and is known by the name of pack fong or paktong in China. In other countries it might be called german silver or any of a dozen other names.

German silver is not a patented alloy. It does not consist of a definite mixture. No certain definite elements go into its makeup. There is no one method for effecting this composition. Any one can manufacture an alloy and call it german silver if he so desires and if the mixture is generally whitish in color and does not exhibit any very unusual properties, no one will question the statement that it is not what it is named. It is simply a new variety of the old product and no one seems to know what the old product really consisted of originally, anyway.

Some of the names of these various white metal products are german silver, nickel silver, silveroid, argentoid, nickeline, navoline, argentan, or any trade name that a company cares to adopt. Many of them apply to definite proportions of the more general product german silver. These particular classes may contain a small percentage of lead, casmium, tin, or iron, and the addition of a small percentage of some of these metals may materially affect the physical properties of the alloy.

These alloys are cast in convenient-sized ingots and may be worked into wires, rods, tubes, or sheets. They may be rolled, drawn, or hammered. Their properties are such that while there is a resemblance of silver the actual cost is much less; they will take a higher polish than nickel ones of their elements; being harder they will wear better than a pure metal; for electrical purposes they are useful inasmuch as their resistance is much higher than that of either copper, nickel, or zinc, the principal metals entering into the alloy.

The proportions most commonly given are copper 50

per cent. nickel 25 per cent, zinc 25 per cent. These proportions may be varied to suit various uses where important factors may be hardness, ductility, malleability, surface polish, electrical conductivity, elasticity, or any physical property.

The uses, to which these various mixtures may be put, are rapidly increasing. Twenty years ago german silver was principally heard of as a wire used for electrical purposes. Most physics students are familiar with it as the "slide wire" on a homemade, Wheatstone bridge. It was found to be valuable there on account of its high resistance, comparatively small change of resistance with temperature, bright clean surface which enabled the operator to make good electrical contact, self preservation of this polished surface, or failure to corrode and hardness which prevented the wire from being scratched or rapidly worn by the sharp sliding contact.

Now it is only necessary to look through the advertising pages of metallurgical magazines to find the uses found for these alloys. As a class they are used for more different purposes than any other group of alloys and as a whole there is probably a greater tonnage of white-metal alloys manufactured than any other, excepting brass. Brass is an alloy of copper and zinc used in various proportions and makes up a group of yellow-metal alloys which are admirable for machining purposes. Of course, however, none of these finer alloys can compare in tonnage with iron and its alloy, steel.

Various trade papers advertise german silver products in their line. In some cases the wholesale manufacturers advertise the alloy in the form of rod, plate, ingot, or stamped article, to manufacturers who finish the article and sell to the retailer or consumer direct.

It is advertised in electrical papers in the form of wire used for resistance purposes chiefly. Nearly all the "resistance alloys" contain copper and nickel but to the more recently devised ones have been added various other metals in small proportions so that they are far better than the old copper-nickel-zinc combination and are advertised under entirely different names.

Frequently the characteristics of a metal appear in an alloy in which that metal enters. There is a recalescent point in nickel at a temperature of about 380 deg. Cent., that is, at that temperature the metal exhibits unusual expansion properties. At that point its electrical resistance and thermal electro-motive force change unusually. The same changes are present to a greater or lesser degree in german silver, thus in a way analyzing it to show whether nickel is present.

One of the biggest lock and key manufacturers in the country uses german silver exclusively for the manufacture of his keys. The percentage of copper runs rather high as it is not especially desirable that the key should be bright or white but instead that it should be tough and hard and not brittle. The better the alloy that goes into the key, the smaller that key may be made and so more convenient to carry, a condition readily appreciable by one who must carry a considerable number of keys on a ring or chain.

Due to the toughness and hardness of german silver it is used as a base for much of our fine silver-plated ware. A spoon of pure silver would bend easily, so it is better to plate silver upon a baser and harder metal, thereby making a cheaper but really better product for the purpose for which it is meant to be used. This basis metal is usually nickel, copper and zinc, or german silver, because it supplies all the desired conditions and besides silver plating adheres well to it. A cheaper grade of fairly good-appearing spoons, knives, and forks is made of the alloy which is itself polished and not plated with silver at all. These are the products that can be bought at the ten-cent stores and answer very well for picnics or campers' use and where a better grade of ware would be a nuisance. The bases for spoons are turned out by the ton or wagon load according to one's way of estimating at the wholesale manufactory. They are stamped out of plates or sheets of the metal which are about one eighth of an inch thick. The handle of the spoon is well shaped but no one would guess that the other end would eventually become the bowl of a spoon. It is cut out either square like a shovel or slightly pointed like the proverbial ace of spades and is perfectly flat. They are cut out of these big sheets of metal at an enormous rate and run in a continuous stream into the receiving boxes. These crude products then go to factories where nothing is done but finishing spoons. Back at the other factory where the bases are being stamped out several different sizes or shapes may be being made and separate streams of these running into boxes placed side by side. If a visitor is taken through the factory he is shown one or more of these forms just cut out which is quite interesting to a novice. But one of these spoons taken from its receiving box is not tossed back into that box. If it is not wanted as a souvenir it is thrown into a scrap box, frequently called the "hell box" and melted up again, because if by chance it should be put into a box with spoons of a different size, its completion and finishing would ultimately cause more trouble and a bigger loss of time than the finished spoon would be worth.

The cases of many watches that sell for from one to five dollars, are german silver. They too are stamped out of the big sheets of metal and just one punch makes a big beginning on a watch case. These are frequently polished to imitate gun metal which of late years has become popular. Just one scratch of a file goes below the imitation surface for the beauty is if anything less than skin deep.

Other uses found for alloys are wherever a strong, tough metal capable of taking a good polish is needed. Brass looks "cheap" beside the white metal, so the latter is used wherever the quantity required is not so much as to entail too great an expense or even in great quantities in luxuriously appointed places. It is to be found replacing nickeled equipment in bathrooms, café, bars, boats and automobiles. For many of these articles only a small amount of nickel is present, without which the copper and zinc would simply be brass. The yellow brass changes gradually to white metal as the percentage of nickel increases and the price also advances in a similar manner.

Tempering and annealing the ingots is an art. German silver would not be classed as an easy metal to work. After the ingot is cast it is heated to a certain temperature and then sprayed with cold water if it is to be softened for wire drawing. A rolling mill is essentially part of a manufactory because rolling better than anything else breaks down or destroys the crystalline structure. If this were not done the product would be quite brittle. When it is ultimately to be drawn into wire the red-hot ingot is started through rolls which gradually transform it into a rod approximately three quarters of an inch in diameter and several feet in length. The rod is a dull red by the time this stage is reached. It is also corroded with oxide and when cool this oxide is removed by pickling in the proper chemical baths. Finally the rod, which has previously been bent into a convenient sized coil, is washed in water at a temperature near that of steam so that when the coil is drawn out of the bath and allowed to drain the temperature of the metal is sufficiently high completely to drive all the water off of it. It is then as soft and ductile as it can be made and is started through draw-plates to reduce it to the finest sized wire. The larger sized draw-plates are simply iron rings. One end of the rod is swaged or sharpened enough to start through one of these rings and is then pulled entirely through and the process repeated with a smaller ring or draw-plate. Finally for the smaller sizes the iron rings are replaced by jewelled dies or draw-plates. When these smaller sizes are reached several of them may be arranged in series and the wire passing through all of them at once is quickly reduced in cross section and increased in length. A piece originally the shape of an ingot a foot in length may be rolled out to a length of forty or fifty feet in the shape of a rod and this rod drawn into a wire a mile or more long, and as it is drawn rolled onto a cylinder as large as a barrel. During the many times that it must pass through the draw-plates it may require annealing as continued drawing tends to harden it so that it begins to "check" on rough places, cracks or sharp splinters begin to appear, which of course would soon ruin the wire and cause it to break when under strain. It is now annealed by placing in a furnace where it can be covered with finely powdered carbon to prevent oxidation, brought to a red heat and allowed to cool slowly before being removed. It is now soft and can be readily drawn again.

When it is rolled into large sheets about one eighth or one sixteenth of an inch in thickness these sheets cool throughout fairly evenly and so are quite soft. They are left in this condition if smaller articles as spoons, keys, or watch cases are to be stamped out of the sheets, but are hardened if the sheet is to be left whole, or to be used, for instance, as the top of a table in a bar. They are hardened by bringing to a red heat and sprinkling or spraying with water. Oxide is then removed by the pickling bath, or, if an extra fine surface is desired the sheet is scraped or literally "shaved" to remove all trace of any foreign particle. It is then smoothed by running through rolls cold and polished by means of revolving wheels of cotton cloths usually about a foot in diameter.

These larger sheets when taken from the rolls will not lie flat but are warped or full of wrinkles. They are flattened or straightened by stretching in just the same manner that the kinks could be taken out of a wire by stretching it. The tension that must be applied to straighten one of these sheets, however, is several thousand pounds.

Some of the physical properties of copper, nickel and zinc are here given, together with the same for german silver as most commonly made, that is about 50 per cent copper, 25 per cent, or less, nickel, and 25 per cent zinc.

These data are taken from such tables as Landolt & Bornstein, the Smithsonian Physical Tables and current magazines. The last column is the author's own invention. It was started through curiosity and proved to be interesting. Where different experimenters give different results in the first four columns the average value has been used.

The fifth or last column has been arrived at by arranging the first three columns, giving to the first one a weight of *two* since the alloy considered contains 50 per cent copper. The author does not make any claims whatever or attempt to advance any legitimate reasons for working such an average as is done except as a matter of curiosity and interest in the results obtained by this simple mathematical means and realizes full well that a much bigger problem is involved than this so-called solution might at first be taken to signify.

Now as to the significance of some of the quantities in that last column.

Since the density of the alloy is greater than the average of the elements composing it we may assume that such a percentage of those elements alloys or mixes well—that they make a compact mass, which presents a smooth surface and a homogeneous interior.

Nothing can be expected by making an average of melting points. Frequently an alloy melts at a temperature below that of any of its elements when pure. Or sometimes the alloy does not have a definite melting point but simply becomes pasty or waxy as if it had lost its crystalline structure and then becomes solid again at a lower temperature as if it were undercooled.

Also since the structure is changed Young's Modulus cannot be predetermined, but it is to be noted that if the percentage of nickel is increased the average in the last column becomes greater and experiment shows that the strength of the alloy increases and just the opposite is true if the percentage of zinc is inc eased.

The specific heats appear to agree beautifully and that the differences are due to experimental errors, but in reality this constant can be determined very accurately and that value of 0.094 obtained for german silver is not an error but a very exact determination. It is the amount of heat calories necessary to raise the temperature of 1 gramme of the substance 1 deg. Cent. when at about room temperature. Here is a fine problem to find why the specific heat of the alloy should be greater than that of any of its elements.

It so happens in this case that the coefficient of expansion agrees pretty well with the average, but it is well known that this is not always so.

Thermal conductivity is one of the big disagreements. The equation in which this constant is used is $H = K \frac{(T_1 - T_2)\ \text{Time}}{\text{Thickness}}$ and means that the amount of heat $H$, in calories, that passes through a block of the substance in question is equal to $K$, a constant which is the thermal conductivity, multiplied by the difference in temperature between the two faces and the time and divided by the distance between the two faces.

An alloy is nearly always a poor conductor. It offers a high resistance to the flow of either heat or electricity. This constant $K$ for thermal conductivity is also dependant upon the temperature. In the equation $K_t = K_o (1 + at)$, $K_o$ is the value of the constant at 0 deg. Cent., $K_t$ the value at some other temperature, $t$, and $a$ is the coefficient which shows the rate at which $K$ changes with temperature. It is to be noted that while $K$ for the alloy is small, yet $a$ is large as compared to that of copper or any of the pure metals.

Similar equation may be written for specific resistance to the flow of electricity and the temperature coefficients of electrical resistors.

The equation for specific resistance is $R = K \times \frac{l}{a}$ or the resistance is equal to a constant $K$, times the length and divided by the cross section of the resistor. This constant for an alloy is always higher than that of the pure metals, which means that it is a poor conductor.

On the other hand the temperature coefficient of electrical resistance is always smaller for alloys than pure metals and in some cases becomes almost zero. The equation is $R_t = R_o (1 + at)$ in which $R$ is the resistance at any temperature $t$, $R_o$ the resistance at 0 deg. Cent. and $a$ the coefficient which shows the rate at which $R$ changes with temperature. For a pure metal $a$ has almost the same value as the coefficient of expansion of a gas, namely: 1/273 or 0.00366. For an alloy this constant can be determined only by experiment.

| | Copper. | Nickel. | Zinc. | German Silver. | Average, 2cu zn nl. |
|---|---|---|---|---|---|
| Density | 8.85 | 8.75 | 7.10 | 8.45 | 8.36 |
| Electrical resistance | $1.60 \times 10^{-6}$ | $12.43 \times 10^{-6}$ | $5.61 \times 10^{-6}$ | $20.89 \times 10^{-6}$ | $5.25 \times 10^{-6}$ |
| Peltier effect with copper | ........ | 4.36 | 0.50 | 2.47 | 2.43 |
| Melting points | 1083 | 1450 | 419 | 1020 | 1010 |
| Specific heat | 0.092 | 0.092 | 0.093 | 0.094 | 0.092 |
| Thermal conductivity | A0.00005 K0.72 | ........ 0.142 | ........ 0.265 | 0.0026 0.07 | ........ 0.138 |
| Young's modulus | 12450 | 23950 | 8734 | 11550 | 14396 |
| Co-efficiency of expansion | $0.167 \times 10^{-4}$ | $0.128 \times 10^{-4}$ | $0.292 \times 10^{-4}$ | $0.183 \times 10^{-4}$ | $0.188 \times 10^{-4}$ |
| Temp. coef. of resistance | 0.0039 | 0.004 | 0.0040 | 0.0003 | 0.0040 |

## NEW BOOKS, ETC.

**The Purchasing Power of Money.** Its Determination and Relation to Credit, Interest and Crises. By Irving Fisher, Professor of Political Economy in Yale University; assisted by H. G. Brown, Instructor in Political Economy in Yale University. New York: Macmillan Company, 1912. 8vo.; 504 pp. Price, $3 net.

Of all sciences there is perhaps none whose teachings appeal directly to a larger class of people than economics. We may not all be engineers, chemists, physicists, or lawyers, but we are all wage earners or capitalists or both. This catholicity of the interests of the science brings some unfortunate consequences in its train. Since everyone is interested, everyone thinks himself also competent to discuss the principles involved, and to draw conclusions; with results which, to the careful thinker and painstaking student, appear often grotesque. To quote from the preface of the work before us: "As some one has said, it would seem that even the theorems of Euclid would be challenged and doubted if they should be appealed to by one political party against another."

It is very unfortunate that the great majority of persons seem to be unable to approach questions of political economy with the true scientific spirit, the spirit which studies facts and relations dispassionately, without regard to personal feelings. Only after such an unbiased study has been made, are we prepared to apply the results to the solution of practical problems which personally affect us and our fellow men. In other words, our first aim must be, not to ask which social or financial system is desirable, but to investigate impartially the properties and consequences of such systems as present themselves. It is only after such an impartial study that we are in a position to attack the practical problem of establishing the desired system in our community. Unfortunately, the course which many would adopt is the very reverse of this. They first acquire a bias for some system, and insist on seeing it introduced and tested on its merits. No engineer would think of building a costly structure without first computing its parts on the basis of known physical laws. But experiments in financial systems are proposed, on a scale which surpasses anything ever attempted by the engineer, without a moment's consideration of the knowledge in the hands of specialists, who could advise us and save us almost unlimited losses.

It should be generally realized, that to meddle in questions of administration involving economics, without having made a special study of the subject and of the writings of authorities thereon, is just as absurd as it would be for the untrained "man in the street" to attempt to construct a locomotive. The only difference is that no sane man is likely to attempt the latter task, because he realizes his ignorance, and the necessity of study to become an engineer; whereas, in matters of economics, every one thinks himself competent to join in the discussion, without making himself familiar with the work of such men of genius as Cournot, Jevons, Walras, Pareto, etc.

The appearance at this season of an excellent book on "The Purchasing Power of Money" is most fortunate, the more so as it is written in a form intelligible to every well-informed reader, and this without any sacrifice of scientific rigor.

It is well worth while to outline briefly the general plan on which Prof. Irving Fisher's book is constructed. It is based, as any sound work on this subject must be, on the so-called *quantity theory of money*. It is unfortunate that this theory has been brought into disrepute by its false applications on the part of incompetent politicians. This does not rob the theory of its worth, and, indeed, it is at the present being accepted by all competent judges.

The quantity theory of currency is perhaps best explained by considering first of all an ideally simple case, and then extending the argument so as to cover the more complicated conditions which prevail in actual practice. It would be difficult to state the case more clearly than in the words of A. Del Mar ("The Science of Money," New York, 1904, p. iii:)

"The monetary sum of the whole number of exchanges in a given time is of necessity exactly equal to the whole sum of circulating money and substitutes for money, multiplied by their respective velocities or frequency of use and re-use. To simplify this problem for the purpose of explanation, suppose that a hundred and fifty thousand millions of dollars' worth of exchanges are to be transacted in a year, and suppose the only kind of money to be used consisted of gold dollars. If the dollars could be used once during the year, it follows that it would take one hundred and fifty thousand millions of them to effect the exchanges. If they could be used and re-used fifteen times a year, three thousand millions of them would suffice to effect the exchanges."

In this simple case, where all purchases are made in gold, we can, in accordance with the exposition made as above, establish the following equation of exchange:

$$M V = \Sigma p Q$$

where $M$ stands for the total amount of gold dollars in circulation, $V$ for the velocity of circulation, or the "rate of turnover" of the gold dollar, i. e., the number of times it changes hands (on an average) during the year. The symbol $p$ stands for the price of a given kind of goods per unit quantity, and $Q$ the total quantity of that kind of goods exchanged for money in the course of the year. There will be as many terms of the form $p\ Q$ in the sum represented by the summation sign $\Sigma$ as there are different kinds of goods exchanged.

To pass from this ideal case to actual conditions, we have to allow for the fact that many purchases are not made against gold, but are settled by check or other substitutes for cash. This simply introduces into the equation of exchange an additional term, so that it now appears in the form

$$M V + M' V' = \Sigma p Q$$

Here $M'$ denotes the total deposits (in dollars) subject to transfer by check, and $V'$ expresses the average velocity of circulation of such deposits.

This is the fundamental equation on which Prof. Irving Fisher bases his discussions. He traces the several influences which affect the factors appearing in this equation, and thus the purchasing power of money, as expressed by the fact that the sum of money $M\ V + M'\ V'$ will buy the value of goods $\Sigma\ p\ Q$. The latter part of the book is devoted to the study of index numbers, which give us a diagnostic means of measuring the purchasing power of money, and thus comparing its value at different points of time; and to the consideration of suggested remedies for the fluctuations and progressive changes in this purchasing power, changes which work hardships for a large contingent of people.

Some of us may not follow Prof. Irving Fisher in this last step. We may feel that his diagnosis is correct, but his cure inadequate. This is in part a matter of opinion, and the reviewer feels safe to say that the author himself looks upon the diagnosis as the most unassailable part of his work, while his suggested cure is tentative. Other proposals may be forthcoming as time goes by. At any rate, a correct diagnosis should protect us against wasting time, energy, and resources on visionary schemes, which in the very nature of things are incompetent to strike the root of such troubles as do arise.

**Silk Manufacturing and Its Problems.** By James Chittick. New York: 1903. 9 x 6 inches; 580 pp. Price, $2.50.

This volume, by James Chittick, contains forty complete articles, each treating of some important phase of manufacturing, distributing or financing, in connection with silk or cotton textiles. It contains a mass of information never before presented in print, and much of it of a kind most jealously guarded by its possessors. Authoritative information and advice on numerous vital matters of policy and practice are now for the first time put at the command of the trade, and the value of the book to every man having textile mill interests is at once apparent.

Silk matters occupy a prominent place, and there are articles on the buying, and on the character of raw silks; adulterations of silk goods; the casting of broad silks and ribbons, (together with valuable tables of weights); whether mills should do their own throwing, dyeing, printing or finishing; cotton yarn used in silk manufacture; and a paper on the denier system of silk counts (originally published in the Scientific American Supplement, June 8, 1912).

For textiles, generally, there are papers on the relation of mills to their commission houses, their salesmen, and their operatives, as well as discussions regarding mill help, and welfare work. Power transmission and humidification are exhaustively treated of, and the paper on testing or conditioning is of special importance.

On the merchandising side, there is discussed the cost of sample collections, changes in merchandising methods, specialization in production, advertised fabrics, making goods for stock, auction sales, foreign markets, imperfections in manufactured goods, claims, cancellations and returns, and how to direct the production of a textile mill, etc.

Financing is taken care of in the articles on capital required in manufacturing, prices to use in stock taking, depreciation of plant, curtailment of mill credits, and a well devised plan for a great textile corporation.

The last article discusses the modern efficiency methods as applied to textiles, a most interesting subject.

Throughout the text is much special and valuable tabular matter, and at the end of the volume are some forty special tables for manufacturers' use.

**State Laws Limiting Marriage Selection Examined in the Light of Eugenics.** By Charles B. Davenport. Cold Spring Harbor: Eugenics Record Office, 1913.

No intelligent man can fail to realize after examining this very useful compilation, how blindly our legislators have proceeded in deciding who may and who may not marry. Marriage laws seem to have been framed either to meet legal situations or to carry into effect ideas of morality not always sound. Dr. Davenport classifies the laws of biological importance restricting marriage into three groups: (1) Laws limiting the physical and mental condition of the consorts; (2) Laws limiting consanguinity; (3) Laws concerning miscegenation or the mixture of races.

The laws which limit the mental and physical condition of the consorts are based upon the conception that marriage is a contract and that the affected person is incapable of making a contract. Very few of the States have framed their prohibitions on eugenic grounds, although it must be admitted that in the laws of Connecticut, Delaware, Michigan, Minnesota, New Jersey, Utah, and Washington there seems to be a dim recognition that biological principles ought to be considered. Dr. Davenport has critically examined State laws in the light of twelve actual cases that have come to his notice and shows how inadequate some of these laws are from the eugenic standpoint. He pleads for a law that should recognize two principles; first, the reproduction of the feeble-minded will not be to an important degree diminished by laws, forbidding the issuance to them of marriage licenses; secondly, while the union of a normal man and a feeble-minded woman usually does not take the form of marriage, yet the case may well arise in the future, as it has arisen in the past, where a mentally vigorous man wishes to marry a socially attractive and beautiful, though defective woman. "Such a marriage may be, from the standpoint of eugenics as from any social viewpoint, quite permissible."

The laws limiting consanguinity and marriage seem to have been framed even more absurdly. Just why is it important to prohibit the marriage of a person with his or her (deceased) consort's step-child, or with the consort's grandchild, derived from an earlier marriage? Why should the laws of West Virginia forbid the marriage of a woman with the husband of her brother's deceased daughter, and yet permit a man to marry his brother's widow? Obviously, these prohibitions belong to the same class as the deceased wife's sister law of England which has been abolished.

As might be expected, the laws forbidding miscegenation are founded chiefly on race prejudice. Of the forty-eight States of the Union, twenty-nine have laws forbidding intermarriage between races. In some Southern States, the possession of less than one eighth negro blood is no longer a barrier to legal marriage. Color seems to be the only element considered, yet there are such factors as mentality and self-control which are heritable and which ought to be considered. It is quite possible that an octoroon may carry all the physical inferiorities of a white ancestor, and none of the superiorities of a black great grandmother, and still be regarded as a desirable citizen in some Southern States. Dr. Davenport urges that in legislation skin color should be forgotten and attention concentrated upon matters of real importance to organized society. Those without self-control or educatability or resistance to serious disease, should be prevented from reproducing their kind. The problem of the socially fit must be treated not as one of color, but as a problem of the spread of feeble-mindedness and physical weakness in organized society.

Dr. Davenport outlines a very interesting plan for State Eugenic Control, which would certainly make our marriage laws more reasonable and more commendable from a social standpoint.

**Die Meteorologische Ausbildung des Fliegers.** Herausgegeben von Dr. Franz Linke. Verlag von R. Oldenbourg. München und Berlin, 1913.

Writers of popular articles on aviation refer to the atmosphere as the "invisible ocean of air." The term is both picturesque and apt; for the ocean of air undoubtedly has its currents, its eddies, its billows and waves, its surf and its ripples. These eccentricities of the atmosphere the aeronaut, whether he sails the blue in a dirigible or in a motor-driven aeroplane, must take into consideration. So far as we are aware, Dr. Linke, whose name is well known to students of meteorology, as one of the ablest men in his chosen field, has given us one of the best little textbooks that can be desired. This new book of his should be studied in connection with his admirable "Aeronautische Meteorologie" and with Rotch and Palmier's "Charts of the Atmosphere."

**The Statesman's Yearbook.** Statistical and Historical Annual of the States of the World for the Year 1913. Edited by J. Scott Keltie, L.L.D., assisted by M. Epstein, M.A. Fiftieth Annual Publication, Revised after Official Returns. Macmillan & Co., Ltd., New York and London, 1913.

The Statesman's Yearbook in the course of time has become an English institution. This year's edition stands out from its predecessors for the reason that it marks the jubilee of an enterprise begun fifty years ago by the late Frederick Martin. For that reason the Editor has endeavored in the introductory matter as well as in the maps to indicate the contrast in certain aspects of the states of the world between then and now. Thus, the political, military and commercial progress of the British Empire is carefully traced during the last half century, while the excellent maps show us what changes have taken place in national boundaries during the same period. Even were this not the jubilee number of the Statesman's Yearbook, the volume would be more than passingly interesting, for the simple reason that during the past year, Africa, Europe and Asia have been stirred by conflicts which have had a profound political influence. The events in Tripoli, Morocco, China and in the Balkans are presented with a conciseness and with a wealth of statistical material, which will be of great aid in understanding the present situation.

**Mathematical Wrinkles.** By Samu[el] Jones. Gunter, Texas: Published by [the] author. 1912. 350 pp. Price, $1.

The book before us represents a colle[ction of] problems in various branches of mathe[matics,] the selection having been made particularly [with] a view to interesting the student by pres[enting] to his mind various peculiar examples such as [are] known to us rather in popular conundrums [than] in text-books of mathematics. Perhaps a [few] examples may serve to illustrate the charac[ter of] the book.

Thus Section 184 offers a proof, s[eemingly] rigorous, of the proposition "All triangles [are] isosceles." In another section we find a de[mon]stration that a part of an angle is equal to [the] whole. Such mathematical curiosities may s[eem] at first sight to be merely entertaining. Bu[t in] point of fact the search for the fallacy inv[olved] is an excellent exercise for the student.

There is also a useful chapter on "Short Me[th]ods," and a number of tables.

The statement on page 285 that elec[tricity] travels at 186,000 miles per second is h[ardly] accurate. It would have been more judicio[us to] state that electromagnetic waves (and li[ght]) travel at this speed *in vacuo*.

The book should prove of great value to [the] teacher as a source from which to draw exam[ples] of more than ordinary interest for his classes.



SCIENTIFIC AMERICAN SUPPLEMENT

Founded 1876

NEW YORK, SATURDAY, AUGUST 30, 1913

Published Weekly by Munn & Company, Inc.
Charles Allen Munn, President
Frederick Converse Beach, Sec. and Treas.
All at 361 Broadway, New York

Entered at the Post Office of New York, N. Y.
As Second Class Matter


The Scientific American Publications

Scientific American Supplement (established 1876) per year . . . $5.0[0]
Scientific American (est. 1845) " . . . . 3.[00]
American Homes and Gardens " . . . . 3.[00]

The combined subscription rates and rates to foreign countries including Canada, will be furnished upon application.

Remit by postal or express money order, bank draft or check

Munn & Co., Inc., 361 Broadway, N. Y.

*The purpose of the Supplement is to publish the more important announcements of distinguished technologists, to digest significant articles that appear in European publications, and altogether to reflect the most advanced thought in science and industry throughout the world.*

## Table of Contents